the OIL AND GAS JOURNAL

MAY 20, 1957

Latest in Refining Technology

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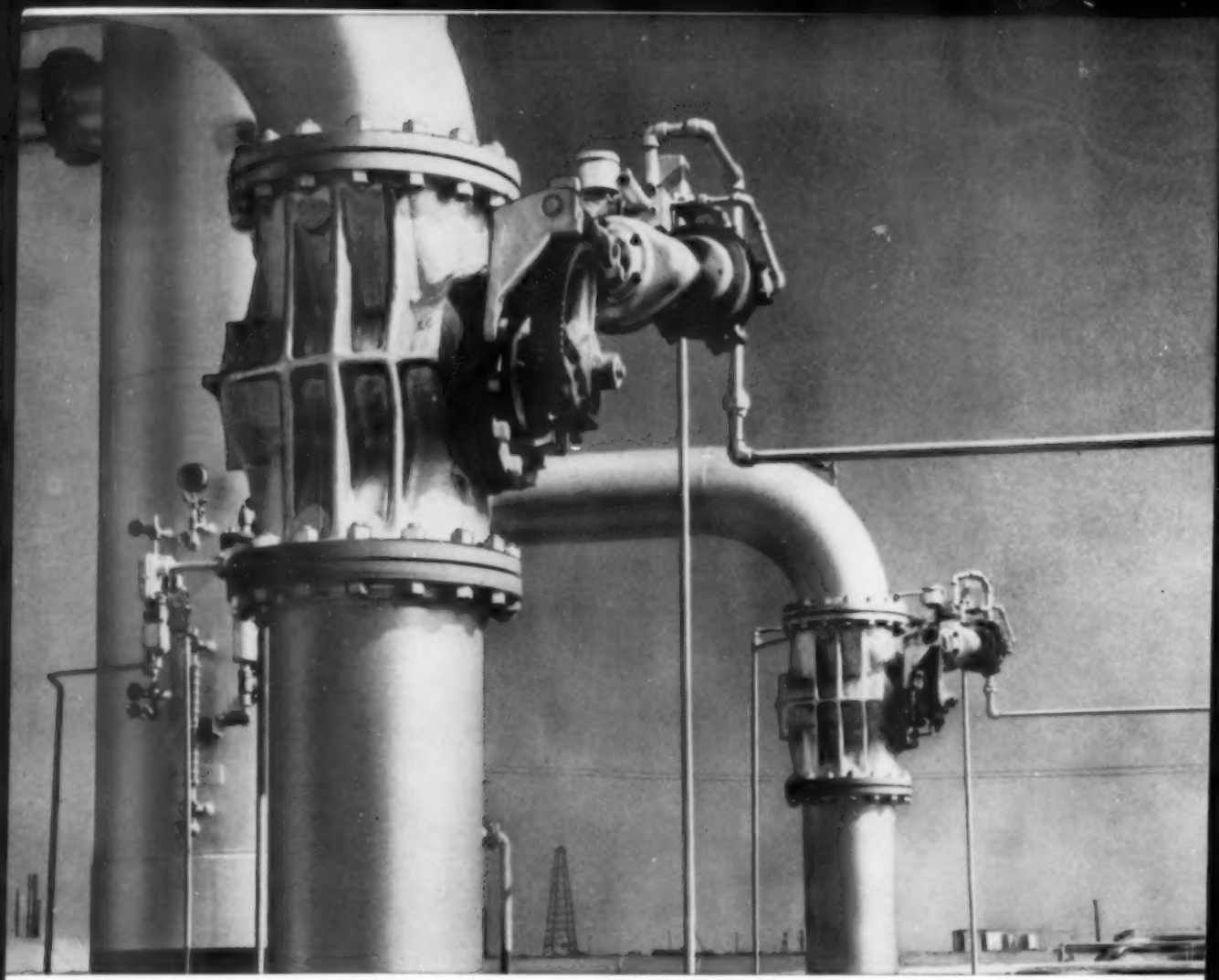

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JOURNAL News Letter

May 20, 1957
Tulsa, Oklahoma

Majors in the Rockies suddenly are keenly interested in oil shale:

At least six of the big oil companies have contacted the U. S. Bureau of Mines regional office in Denver. They are asking for precise details on where they can obtain more oil-shale property. Bureau Director J. H. East, Jr., says this is the first time the majors have shown anything beyond academic interest in shale.

East attributes the sudden interest to two factors: Middle East crisis which put a premium on domestic energy sources...Steadily rising costs of exploration and drilling for domestic petroleum.

But Union Oil's experience also may be a factor. Union Oil's president A. C. Rubel predicts a promising shale-oil industry producing about 2,000,000 bbl. daily within 5 to 10 years. His company's shale-oil experimental station has just gone on stream in Colorado. Rubel says the cost barrier will be broken within a year and shale oil will be able to compete commercially then with petroleum.

If so, it will add 900 million barrels of shale oil in Colorado to the nation's fuel reserves.

CRISIS IN GAS: Colorado Interstate Gas may be in serious financial trouble. The prosperous company's president W. E. Mueller says it faces bankruptcy under rates ordered by an FPC examiner. The examiner disallowed most of two proposed rate increases. He ruled the firm is not entitled to commodity value or a fair-field price for its own produced gas. Since Colorado Interstate produces 62 per cent of its gas, this means a $15 million annual rate cut and refunding $33 million in higher rates already collected. The pinch: Income on this basis won't even cover Colorado Interstate's present debt costs.

Industry leaders are making a last-ditch stand in Washington to persuade the Eisenhower administration to withdraw its two proposed amendments to the Harris-O'Hara gas bill. If effort fails, insiders say the bill has practically no chance.

OIL RANK: A dilemma for those who like to rank the oil companies: Who's on second? Latest statistics show Jersey Standard still tops all

competitors in size by a large margin. But the second-ranking company depends on how you figure. Gulf is second in total assets--$2.8 billion. Socony Mobil is second in gross income--$2.75 billion. Texaco is second in net income--$302 million.

The tip that Robert B. Anderson will be the next Secretary of Treasury in the Eisenhower cabinet is proving true. Date for Humphrey's resignation and Anderson's entry is now July 1.

LABOR: The big swing is now for a 6 per cent pattern of wage increases in the oil industry. Making the 6 per cent offers to unions now are Gulf, the Jersey Standard family of companies, Magnolia, Phillips, Texaco, Atlantic Refining.

O.C.A.W. union, which has steadfastly rejected earlier offers of 5 per cent more, says it'll accept 6 per cent. Union spokesmen say the 6 per cent offers actually make a package of 18 cents more--16 cents in wage increases and 2 cents in more fringe benefits. This is two-thirds of the way toward labor's original demand of 27 cents.

First violence has marked union attempt to organize drilling crews in Permian basin of West Texas. Four union leaders were jailed last week and later freed on bond. They had leased 3 acres near a drilling site and plowed the land for a "garden." In the process a gas line leading to the rig was broken. A battle royal erupted when rig crewmen came on the land to repair the line. Later union men plowed up the access road to the rig and erected a dirt barricade, but it was knocked down by bulldozers. Although the scene was quiet at weekend, West Texas oil men are expecting other incidents.

EXPLORATION: Oil hunters in Oklahoma are jumping into the state' deepest wildcat campaign yet. The objective is the thick Ordovician section of the Anadarko basin covering the western part of the state. British-American's success at Knox field in Grady and Stephens counties sparked the ultradeep play. B-A uncovered the deepest production in the state last year, confirmed it this year, and is drilling on its sixth test. Pan American Petroleum is busy at another deep one at Knox. Other plans call for a 20,000-ft. wildcat on the large Fort Cobb anticline, a 17,000-ft. wildcat at East Cement dome, and deep tests for West Velma, Cruce, Chickasha, and Araphoe.

Phillips has agreed to unusual conditions in Venezuela as part of its deal for Block 17 Concession in Lake Maracaibo. Phillips will grant the Venezuelan Government free use of its patent on Marlex 50 plus full technical assistance necessary to produce the plastics material. The American firm also will lend Venezuela technical cooperation in obtaining radioactive isotopes and in other experiments with atomic energy.

Shell has completed its 1 Alamosa Ranch for 480 bbl. of 40°-gravity oil daily from the Pennsylvanian at 6,101-23 ft. The wildcat opened first production in the Palo Duro basin, last of the three Texas Panhandle basins to give up oil.

The Paradox basin producing trend has been pushed farther westward in Utah. Shell's 1 Tohonadla in San Juan County flowed at an estimated rate of 528 bbl. daily on test at 4,995-5,050 ft. Carter has offsetting acreage. El Paso Natural and Atlantic Refining also have holdings in the area.

Shell is joining the parade into Bolivia. It has an exploration license covering about 4,740,000 acres on eastern flank of the Andes in central Bolivia, north and east of established production. Shell already has done surface exploratory work in the country.

Geologists now have a new combination of techniques for more accurate mapping. It's photogeology plus photogrammetry, which enable geologists to work up outcrop patterns. Elevation data necessary for the structural contour maps are furnished by stereoplotting instruments.

DRILLING: A report from the Bureau of Mines says oil-base circulating fluids will cut down damage to wells and increase total recovery. After several years of study in California, bureau researchers say water-base drilling muds tend to plug formations. Tests show damage to 5 of 9 wells drilled with a water-base fluid. But only one in 14 showed damage when drilled with the oil-base type.

California drilling costs, already above the national average, are still on the upward trend as oil gets harder to find. The result may be fewer companies looking for oil in the state. That's the report given a Pacific Coast session of the A.P.I. Production Division. Reasons for higher drilling costs in California: Wells there are deeper, more directional drilling because of difficult formations, longer completion work with special and expensive completion fluids.

Oil operators soon may be slant-drilling under the National Cemetery at Natchez, Miss. The cemetery is on the known geological structure of a producing field and is being drained by commercial development outside the reservation. The Army has transferred control of the two sections of land to Interior for oil leasing.

PRODUCTION: Magnolia is running first pilot tests to see if Midland, Tex., sewage effluent will solve a vexing water-supply problem. Magnolia needs to find enough water for a full-scale flood in the 16,000-acre, unitized Pegasus field. It is prepared to spend $1.5 million on a treating plant and 18-in. concrete pipeline if tests prove successful. In turn it would get 2,800,000 gal. of water daily.

Fields producing low-gravity, highly viscous crude can be flooded successfully. That's the report from a 3-year pilot test by Union Pacific Railroad in the tar zone of California's Wilmington field. Results to date indicate a substantial increase in ultimate recovery.

Production of natural gas off the Louisiana coast will soar by year's end. Lack of pipelines has kept production nearly constant during past year while offshore oil production rose 50 per cent. Two major offshore gas lines before the end of the year promise to tap some of the biggest gas reserves yet discovered and give an incentive for more development drilling.

First tanker load of crude from Safaniya, world's largest underwater oil field, has been lifted by a Japanese vessel. Oil flowed through new 140-mile pipeline from the offshore Persian Gulf field to Ras Tanura. Field's production now is 50,000 bbl. daily, will hit 125,000 bbl. daily by midyear.

REFINING: Gleanings from A.P.I. midyear refining gathering in Philadelphia:

...Commercial pentane and hexane isomerization has arrived. First hexane isom unit will be built at Shreveport refinery of Atlas Processing Co. It will be a U.O.P. Penex unit of 3,000-bbl. daily feed capacity and designed to make 98 leaded R.O.N. products. Other units of even larger capacity are on the design boards. But refiners can't count on mixed pentane and hexane isomers to help them much on road-octane ratings above 100. The prime exceptions, of course, are isopentane and 2,3-dimethyl butane which give excellent results when blended with all types of base stocks.

...Isomerization to make branched-chain paraffins from normal ones is getting more attention from refiners. Butane isomerization is picking up speed as alkylation comes more into the picture. Several butane isom units are now being built or planned to make isobutane feed stock for motor-fuel alkylate.

...Here's a picture of tomorrow's gasoline: Refiners will make premium of better than 110 R.O.N. on a 40/60 volumetric split with a 98-R.O.N. regular grade. It will cost the refiner 6.1 cents per gallon more to accomplish this. But this year refiners may chalk up a record rise in octane ratings of premium-grade gasoline. Already 99 and 100 octane are available over much of the nation.

Detroit talks of 12:1 as the probable ultimate in compression ratios with current engine designs. Future cars in this class will require fuel of about 110 R.O.N. It is technically possible now to make a substantial quantity of this premium motor fuel with processes already developed. But the costs are high. It's another case of technique maintaining a lead on economics.

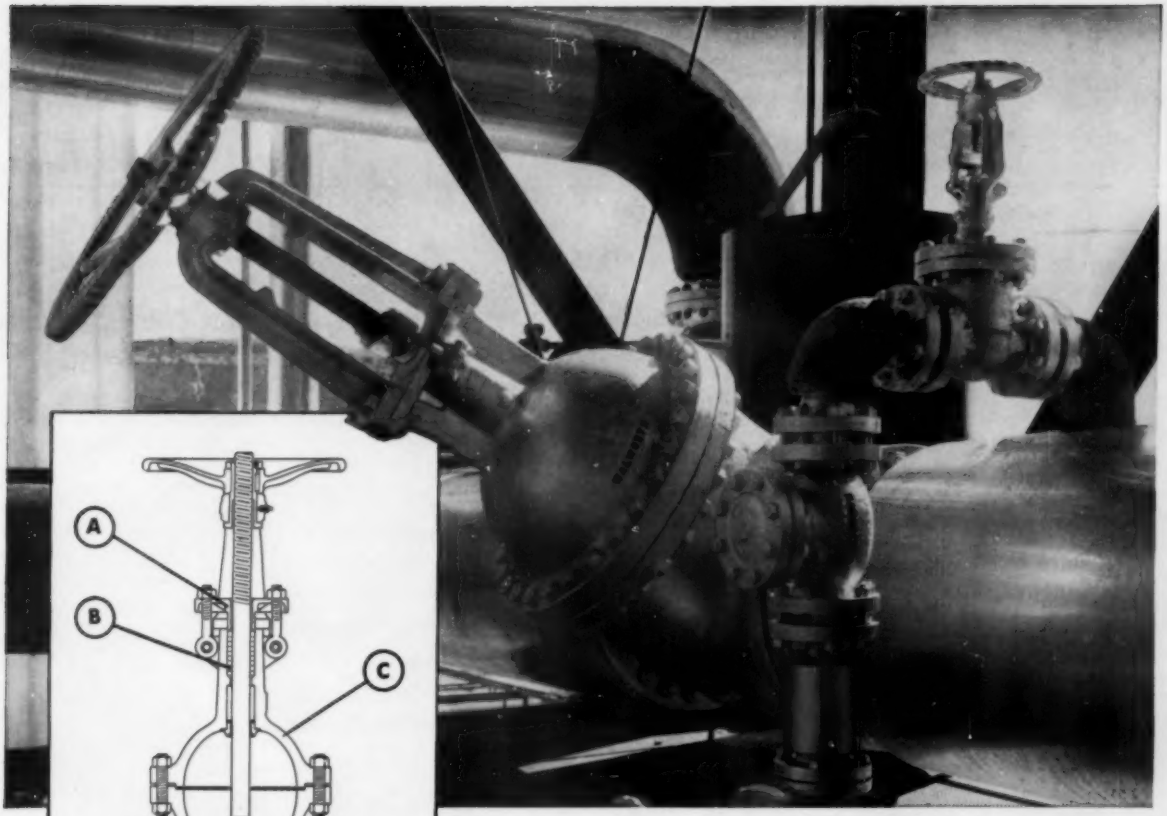
A new 55,000-bbl. refinery in Panama is now definite. Contract for the $33 million project has been let to Foster Wheeler Corp. for work starting within 60-90 days. John Shaheen, New York, and Eugene du Pont, III, Wilmington, have put $1.4 million of their own money into the project. Banks and insurance companies have put up the rest. The project has an almost foolproof look: A tax umbrella is guaranteed for 25 years. Ten-year sales contracts are in hand for 38,000 bbl. daily. A built-in price spread is assured. Breakeven point is 20,000 bbl. daily throughput, and payout time is estimated at 4-1/2 years.

PIPELINING: Common-carrier pipelines are having their say now in a battle with producers before Texas Railroad Commission. Spokesmen for pipelines are making these points: Producers actually want markets for their crude and not transportation. Pipelines will move the oil if the producer has a buyer.

Nine smaller American oil companies have been cut into planning for the 1,500-mile, $840 million big-inch pipeline from the Middle East to the Mediterranean. The nine are those which hold a 5 per cent interest in the Iranian consortium.

Gas is expected to be moving into Winnipeg by early September with work on Trans-Canada Pipeline now moving along smoothly. Meanwhile, work on Westcoast Transmission's line in Canada is 70 per cent complete and moving on schedule.

The world's first coal-slurry pipeline is now operating without a hitch. Screening equipment is working properly again and the coal-water mixture is going through the 108 miles of 8-in. line.



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A.P.I. REFINING REPORT

Isomerization Adds to Your Octane Picture . . . 132
By H. R. Grane, J. K. Ozawa, and G. R. Worrell
Production of isopentanes not only offers the refiner an excellent means of meeting research octane-number requirements, but gives him a superb component for super-premium fuels.

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Upgrading the C_5 and C_6 Paraffins . . . 142
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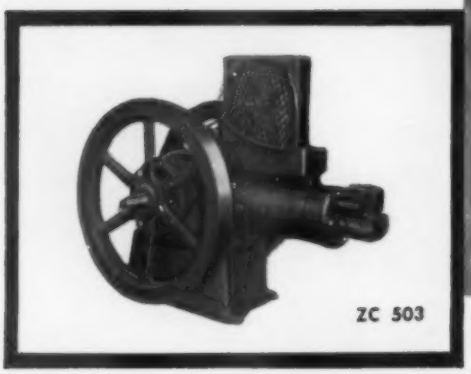

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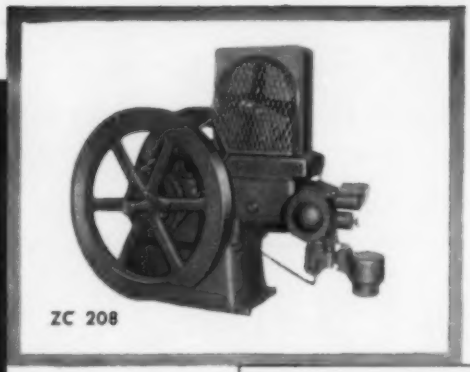

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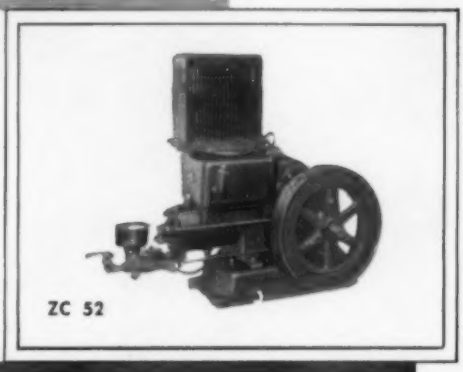

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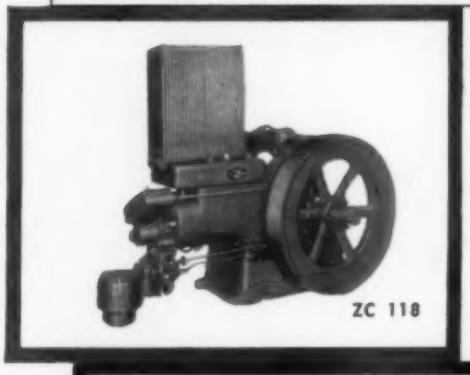

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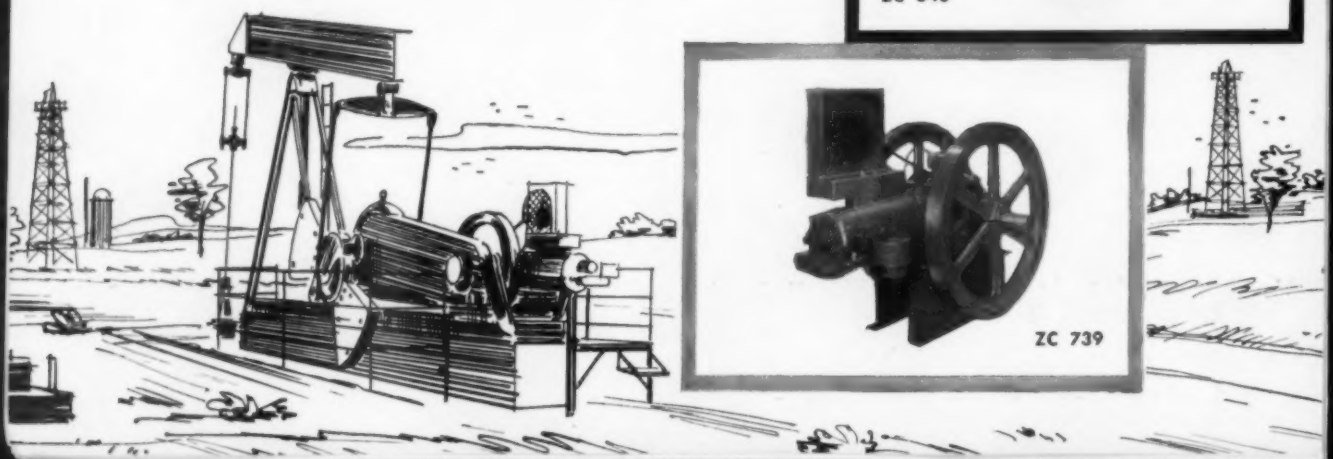

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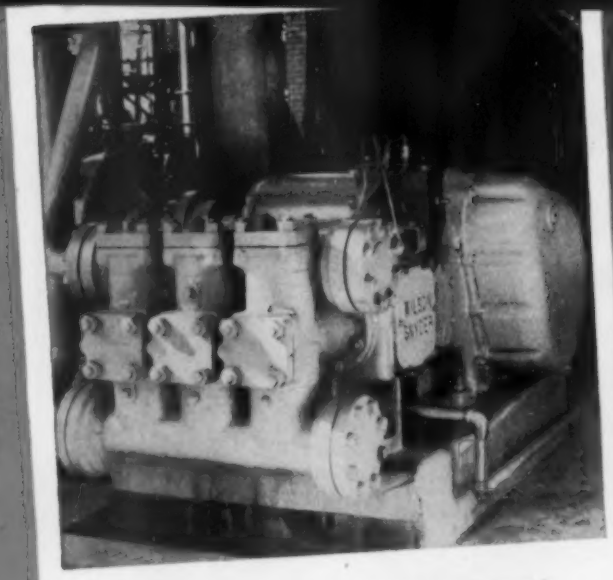
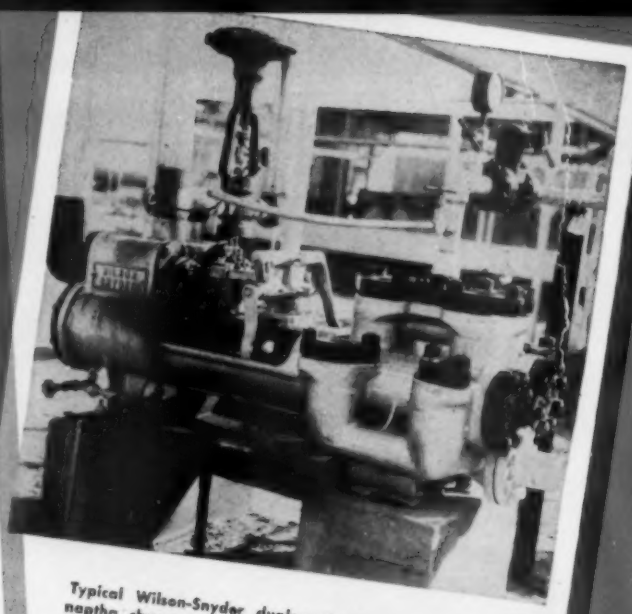


Typical Wilson-Snyder triplex plunger power pump in Universal Oil Products Platforming reactor charge service.



Typical Wilson-Snyder duplex steam pump handling naptha charge in an Atlantic Catforming installation.

Wilson-Snyder Reciprocating Pumps
—your best buy for LOW-Capacity, HIGH-Pressure Services

RECIPROCATING pumps offer many money-saving advantages over multistage centrifugals from 20 to 200 gpm when the differential head in feet is over 20 times the gpm.

LOW OPERATING EXPENSE—85 to 90% efficiency over the complete operating range is generally accepted for roller-bearing-equipped power pumps. The efficiency range of 20% to 60% for centrifugal pumps means that the user must have prime movers 425% to 42% larger than required for comparable reciprocating power pumps. *Think what this means in power savings!*

LOW MAINTENANCE EXPENSE — Reciprocating pumps develop high pressure at moderate speed and running clearance, whereas centrifugals depend on high speed at very close running clearances to develop pressure. Maintenance engineers know that grit, welding beads, mill scale, etc. in suction lines and vessels, as well as unstable suction conditions, can cause serious seizures and mechanical seal failures of multistage centrifugal pumps; with costly operating delays and expensive replacements. Why risk such failures to save a little floor space when dependability is your most important need?

EXPERIENCE—For over 75 years, Wilson-Snyder has furnished heavy-duty pumps of the highest quality, and performance records in thousands of refinery installations throughout the United States and foreign countries have established them as the industry's finest pumps. As a builder of both centrifugal and reciprocating types (including power and direct-acting steam) you can be sure of an unbiased recommendation as to which type will best suit your conditions.

Give your nearest "Oilwell" Pump Specialist an opportunity to quote on Wilson-Snyder pumps for your requirements.

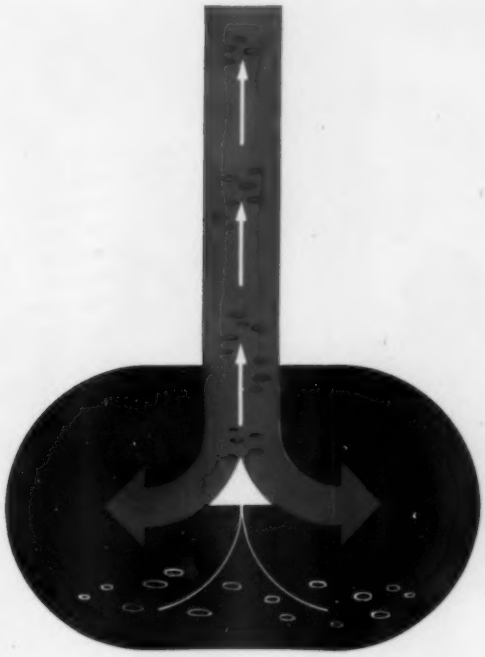
OIL WELL SUPPLY
DIVISION UNITED STATES STEEL CORPORATION
Executive Offices—**DALLAS, TEXAS**
with Refinery Equipment Specialists at

Beaumont, Texas		Braddock, Pa.
Calgary, Canada	Chicago, Illinois	Corpus Christi, Texas
Dallas, Texas	Houston, Texas	Los Angeles, Calif.
New Orleans, La.	New York, N. Y.	Odessa, Texas
Ponca City, Okla.	Shreveport, La.	Tulsa, Okla.

USS

"OILWELL"
TRADE MARK

UNITED STATES STEEL



FIRST...

AND STILL FOREMOST

HALLIBURTON'S *HYDRAFRAC** PROCESS

When hydraulic fracturing first proved its effectiveness in stimulating recovery from oil-starved wells, the original Hydrafrac Process was the basic fracturing technique. After 8 years and many new developments in fracturing fluids and techniques for treating newly encountered conditions, Halliburton's Hydrafrac Process continues its unbroken record of success in most types of formations.

When the BOPD of that well of yours begins to drop and profits begin to dwindle, you might be wise to consider Hydrafrac, and the exclusive Halliburton techniques that make it more effective... the "old reliable" that helps get more oil from most any well... new or old.

Putting more oil in your tanks with Halliburton's Hydrafrac Process, or any other Halliburton fracturing technique suited to your particular well conditions, is Halliburton's primary objective. For unbiased recommendations, it will pay you to talk it over with your Halliburton representative. Call your local or district office or write the Halliburton Oil Well Cementing Company, Duncan, Oklahoma.

Ask for the bulletin: "Elements of Hydraulic Fracturing"

*REG. U.S. PAT. OFF.

HALLIBURTON

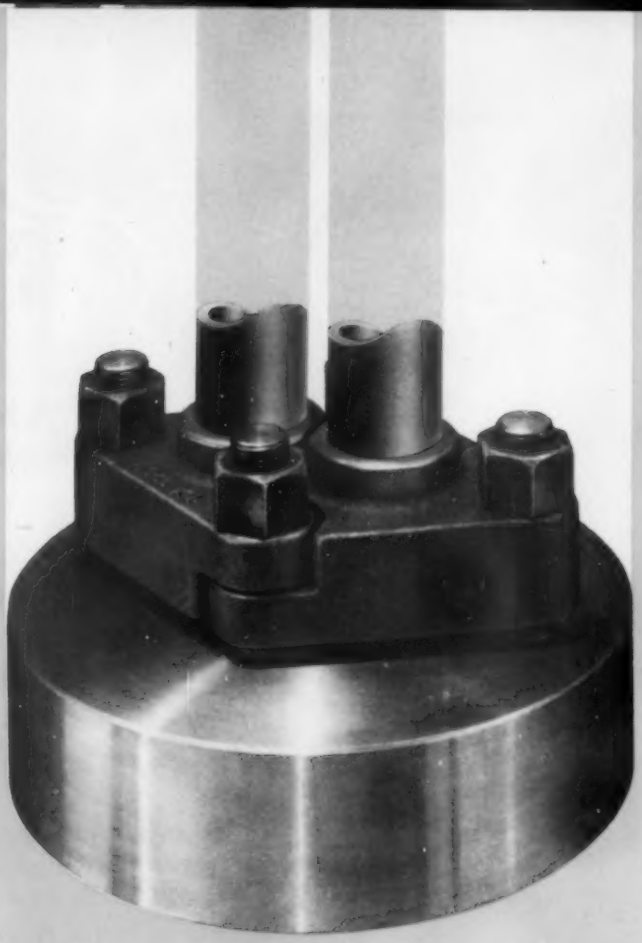
OIL WELL CEMENTING COMPANY

PIONEERS IN FRACTURING SERVICES

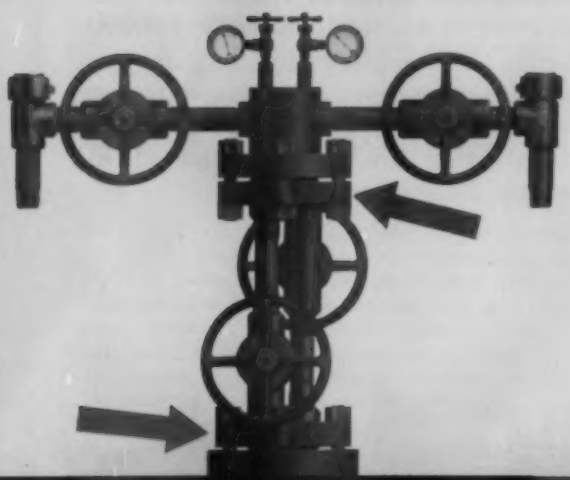
JUST MINUTES AWAY FROM ANY RIG

it's new!

THE O·C·T DELTA FLANGE



BEST THING THAT EVER HAPPENED TO A DUAL STRING TREE



Developed and proved by O-C-T, Delta Flanges are the latest improvement in dual string tree construction.

O-C-T Delta Flanges are unusually strong because each flange half is supported — in perfect balance — by three equally spaced studs and nuts. This balance, plus compact design, accounts for unusual strength and freedom from leakage. Laurent Seal Rings are utilized to keep the pressure area at a minimum.

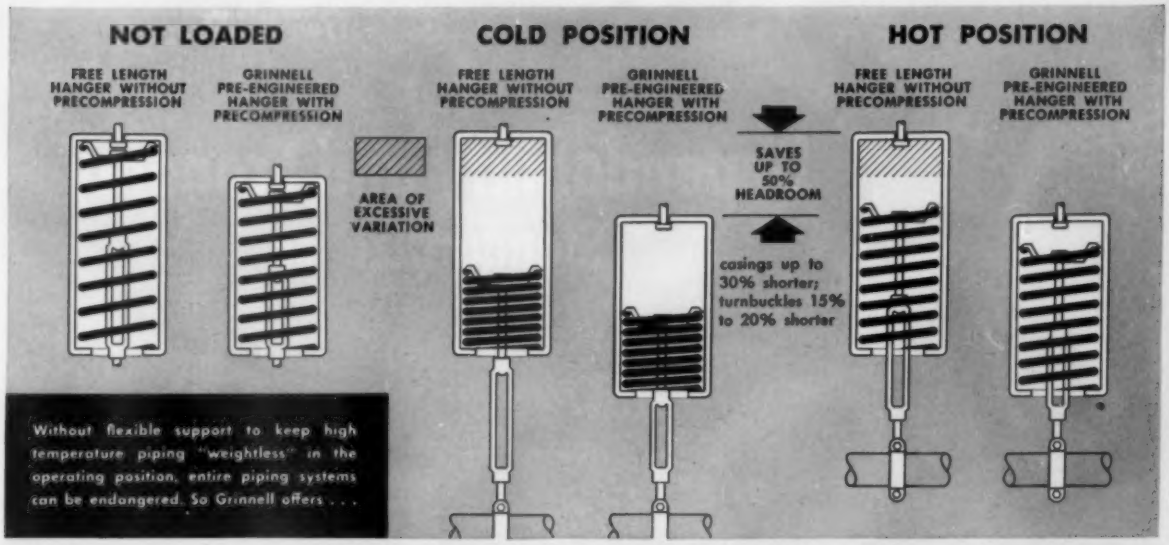
Ask your O-C-T Representative about the many advantages of Delta Flanges or write for complete information and literature.

O·C·T

OIL CENTER TOOL CO.

Export Representatives: South America — East West Oiltools, C. A., Del Lago Hotel, Maracaibo, Venezuela. Address Export Inquiries for All Other Countries to P. O. Box 3091, Houston, Texas.

DELTA FLANGES ARE JUST ONE MORE REASON WHY O-C-T DUAL STRING TREES HAVE SET THE INDUSTRY STANDARD


NOT LOADED
COLD POSITION
HOT POSITION
FREE LENGTH HANGER WITHOUT PRECOMPRESSION
GRINNELL PRE-ENGINEERED HANGER WITH PRECOMPRESSION
AREA OF EXCESSIVE VARIATION
SAVES UP TO 50% HEADROOM
casings up to 30% shorter; turnbuckles 15% to 20% shorter
Without flexible support to keep high temperature piping "weightless" in the operating position, entire piping systems can be endangered. So Grinnell offers . . .

Precompressed Hangers for Safer Support of Piping

Helical coil springs are widely used in hangers for flexible support of piping which moves up or down during thermal expansion. The A.S.A. code for pressure piping requires that variable spring hangers support at least a minimum of 75% of the pipe's weight for a pipe that rises (relaxing the spring) and no more than 125% of the pipe's weight for a pipe that lowers (compressing the spring) during operation.

Precompression patented Grinnell principle

To guard against the spring's supporting force exceeding the limits of variation, Grinnell developed and patented a variable spring hanger design. The steel casing holds the spring permanently precompressed, at the threshold of the hanger's working load range. This prevents the spring decompressing into its area of excessive variation.

Pre-set is not a substitute

As a partial substitute for this patented precompression, some manufacturers insert a spacer between the top end of a free-length hanger casing and the spring to hold the spring's height temporarily within the working range during shipment and erection.

Another device requires the manufacturer to drill symmetrically opposite holes in the casing walls and insert a bolt to hold the spring's height within the working range. When these devices are removed from the hanger and discarded, the spring can decompress, resulting in high variability in supporting force.

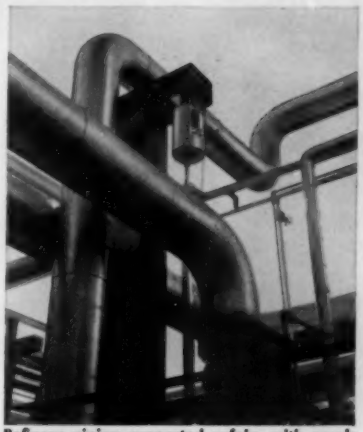
Cold-setting a universal factory service

For the erection crew to avoid having to compress the spring down to the erected position, the manufacturer can compress the spring down to this height. Grinnell can provide a cold-set bolt in precompressed hangers.

Less headroom required by Grinnell Hangers

Shorter hanger casings made possible by Grinnell's patented precompression, reduce bulk shipping weight and required headroom by eliminating undesirable height. Installation is simplified by this shorter casing and also by an integral load scale with load indicator.

Additional headroom is saved by a correspondingly shorter turnbuckle. These precompression advantages are available in short spring and double spring models as well as standard spring models.



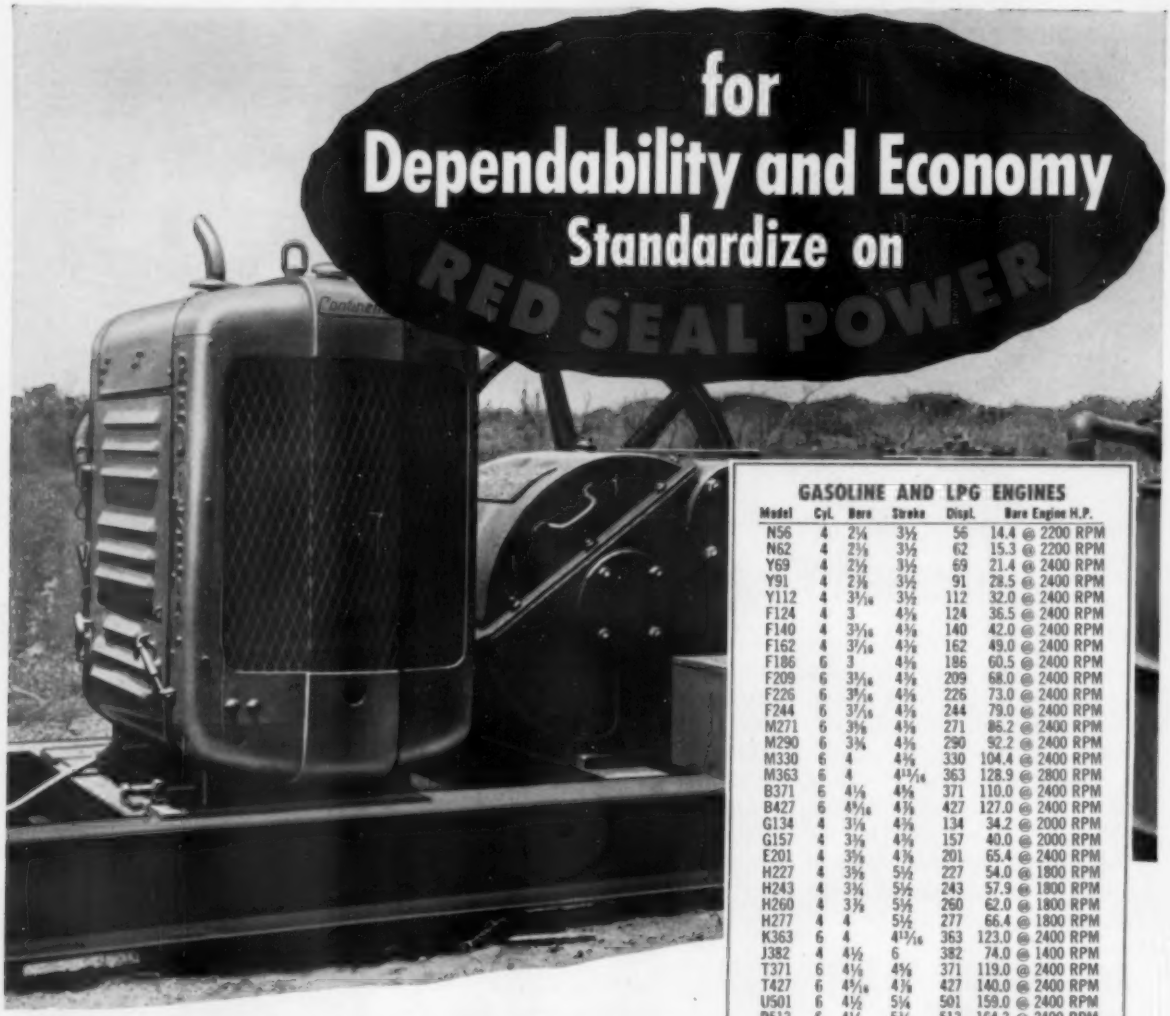
Refinery piping supported safely, with ample flexibility but low headroom.

Available in 63 standard units

Grinnell Variable Spring Hangers are available in 21 sizes each of short, standard and double spring models . . . for maximum travel of 1¼, 2½ and 5 inches respectively within working load ranges. Load capacities extend from 43 lbs to 30,550 lbs. The maximum variation in the standard size per ½-inch deflection is 10½% of rated capacity; inversely proportional in short spring and double spring models.

For further information

If you have a pipe suspension problem, you are invited to write: — Grinnell Company, Inc., 246 West Exchange Street, Providence, R. I.



A product of more than 55 years' specialized experience, Continental Red Seal oil field power embodies an array of quality features—many of them exclusive—that make for dependability, economy and long trouble-free life. The Red Seal Model F-162 shown above, operating in Stonewall County, Texas, replaced another Red Seal which had been in pumping service continuously for eight years. . . . Red Seals are engineered for every oil field application. They are available at closely-spaced power levels, for use on all standard fuels. Ask your oil field supply store or get in touch with your nearest Continental office.

• • •

GASOLINE AND LPG ENGINES

Model	Cyl.	Bore	Stroke	Displ.	Bare Engine H.P.
N56	4	2¼	3½	56	14.4 @ 2200 RPM
N62	4	2⅜	3½	62	15.3 @ 2200 RPM
Y69	4	2½	3½	69	21.4 @ 2400 RPM
Y91	4	2⅞	3½	91	28.5 @ 2400 RPM
Y112	4	3 1/16	3½	112	32.0 @ 2400 RPM
F124	4	3	4⅜	124	36.5 @ 2400 RPM
F140	4	3 1/16	4⅜	140	42.0 @ 2400 RPM
F162	4	3 1/16	4⅜	162	49.0 @ 2400 RPM
F186	6	3	4⅜	186	60.5 @ 2400 RPM
F209	6	3 1/16	4⅜	209	68.0 @ 2400 RPM
F226	6	3 1/16	4⅜	226	73.0 @ 2400 RPM
F244	6	3 1/16	4⅜	244	79.0 @ 2400 RPM
M271	6	3⅛	4⅜	271	86.2 @ 2400 RPM
M290	6	3¼	4⅜	290	92.2 @ 2400 RPM
M330	6	4	4⅜	330	104.4 @ 2400 RPM
M363	6	4	4 11/16	363	128.9 @ 2800 RPM
B371	6	4⅛	4⅜	371	110.0 @ 2400 RPM
B427	6	4 5/16	4⅜	427	127.0 @ 2400 RPM
G134	4	3⅛	4⅜	134	34.2 @ 2000 RPM
G157	4	3⅛	4⅜	157	40.0 @ 2000 RPM
E201	4	3⅛	4⅜	201	65.4 @ 2400 RPM
H227	4	3⅝	5½	227	54.0 @ 1800 RPM
H243	4	3¾	5½	243	57.9 @ 1800 RPM
H260	4	3⅞	5½	260	62.0 @ 1800 RPM
H277	4	4	5½	277	66.4 @ 1800 RPM
K363	6	4	4 11/16	363	123.0 @ 2400 RPM
J382	4	4½	6	382	74.0 @ 1400 RPM
T371	6	4⅛	4⅝	371	119.0 @ 2400 RPM
T427	6	4 5/16	4⅞	427	140.0 @ 2400 RPM
U501	6	4½	5¼	501	159.0 @ 2400 RPM
R513	6	4½	5⅜	513	164.3 @ 2400 RPM
R572	6	4½	5⅜	572	182.4 @ 2400 RPM
R602	6	4⅝	5⅜	602	191.7 @ 2400 RPM
V603	8	4¼	4¼	603	220.0 @ 2800 RPM
S749	6	5⅛	5½	749	217.0 @ 2200 RPM
S820	6	5⅛	5½	820	237.0 @ 2200 RPM

CUSHIONED POWER DIESEL ENGINES

Model	Cyl.	Bore	Stroke	Displ.	Bare Engine H.P.
ZD129	4	3¼	3⅞	129	34.0 @ 2000 RPM
GD157	4	3½	4½	157	39.0 @ 2000 RPM
*ED201	4	3⅝	4⅜	201	45.8 @ 2000 RPM
HD243	4	3¾	5½	243	55.0 @ 2000 RPM
*HD260	4	3⅞	5½	260	59.0 @ 2000 RPM
*HD277	4	4	5½	277	63.2 @ 2200 RPM
*JD382	4	4½	6	382	72.5 @ 1600 RPM
TD427	6	4 5/16	4⅞	427	106.0 @ 2000 RPM
RD572	6	4¼	5⅜	572	154.0 @ 2000 RPM
VD603	8	4¼	4¼	603	175.0 @ 2600 RPM
SD802	6	5 5/16	5½	802	202.0 @ 1800 RPM

*Available for industrial applications only.

SERVICE FACILITIES AND GENUINE RED SEAL PARTS AVAILABLE EVERYWHERE

CONTINENTAL MOTORS · Powerful as the Nation · AMERICA'S STANDARD

Continental Motors Corporation

MUSKEGON, MICHIGAN

WORLD'S LEADING INDEPENDENT MANUFACTURER OF INTERNAL COMBUSTION ENGINES, CONTINENTAL MOTORS OPERATES PLANTS IN ATLANTA, DALLAS, DETROIT, MILWAUKEE, MUSKEGON, AND TOLEDO, AND IN ST. THOMAS, ONT., PRODUCING AIR-COOLED AND LIQUID-COOLED ENGINES FOR USE ON LAND, AT SEA AND IN THE AIR.

How to get the longest tube life per dollar! *Ask the experts!*

THE Timken Company offers 22 different high-temperature tube steels to solve your problems of heat, pressure, corrosion and oxidation. *One* of these tube steels has the analysis most suited to your needs, gives you maximum tube life per dollar of cost.

To find this analysis, *ask the experts!*—the metallurgists of The Timken Roller Bearing Company.

More than 20 years of experience has made Timken Company metallurgists recognized authorities on high-temperature steels. You put this backlog of experience to work for you when you consult these experts. They'll study your specific requirements, then recommend the one tube steel that fits them—most economically.

And you can be sure of uniform high quality in the Timken steel you get. One reason: we make our own fine alloy steels in electric furnaces. This enables us to maintain rigid quality control from melt shop through final inspection.

Timken Company metallurgists will be glad to help you solve your tube steel problems. When you *ask the experts,* you get longest tube life for your dollar. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable: "TIMROSCO".

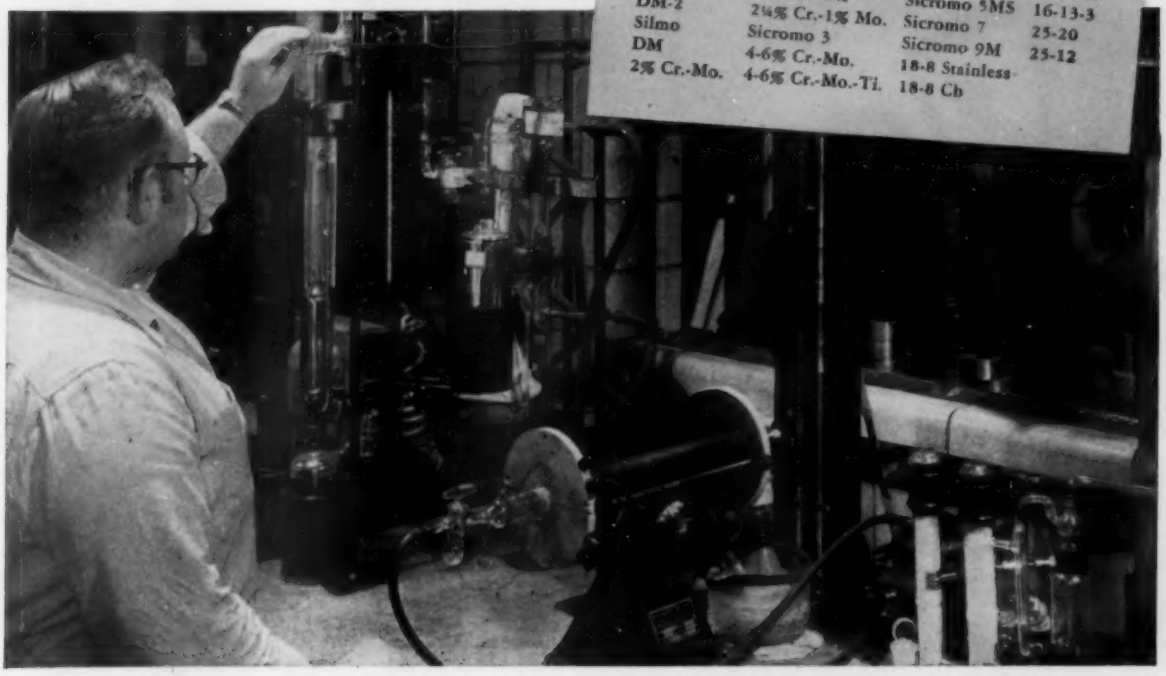
This month's report is on:

DM-2 STEEL

Suggested as a substitute for 0.50% Mo. steel. Has greater creep strength and somewhat better corrosion and oxidation resistance than 0.50% Mo. steel. For use in cracking furnace tubes, high pressure boiler tubing, superheater tubing and high temperature steam piping.

22 TIMKEN® STEELS FOR HIGH TEMPERATURE SERVICE

Carbon	Sicromo 2	Sicromo 5S	18-8Ti.
Carbon-Mo.	Sicromo 2½	Sicromo 5MS	16-13-3
DM-2	2¼% Cr.-1% Mo.	Sicromo 7	25-20
Silmo	Sicromo 3	Sicromo 9M	25-12
DM	4-6% Cr.-Mo.	18-8 Stainless	
2% Cr.-Mo.	4-6% Cr.-Mo.-Ti.	18-8 Cb	

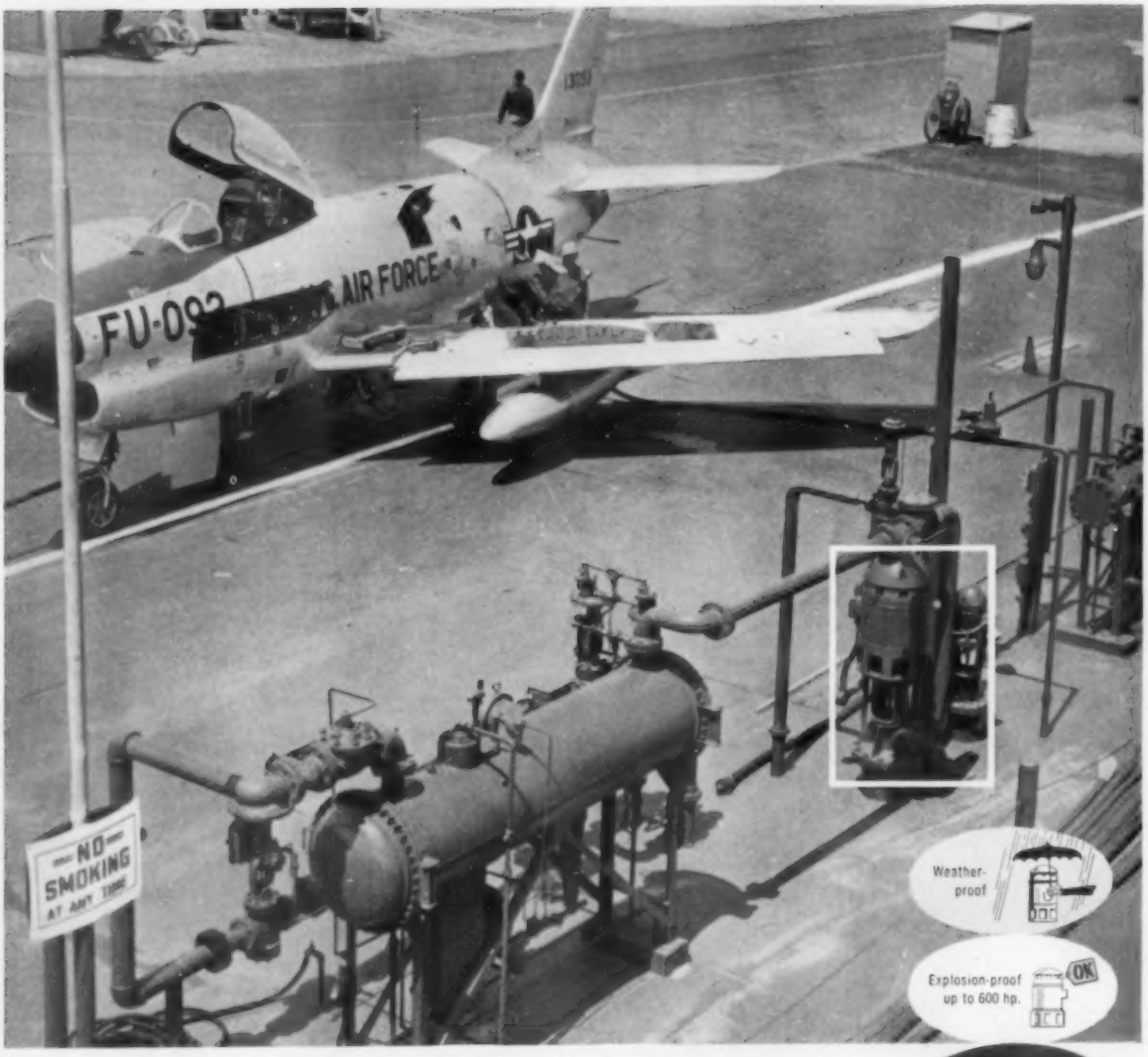


This chlorination equipment helps us determine cleanliness of our steel by purifying extracted non-metallic residues. It's one of many ways we make sure you get steel of uniform high quality.

TIMKEN *Fine Alloy* STEEL

TRADE-MARK REG. U. S. PAT. OFF.

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS STEEL TUBING



This job needs a ready motor!

Louis Allis vertical motors dependably handle vital jet refueling in rugged outdoor service

Air Force defense installations demand equipment that's ready today, tomorrow, and always. There's no time for mistakes. That's why Louis Allis motors are counted on for dependability. Illustrated above are two typical examples of service where instant action is vital.

The installation is an Air Force jet refueling site. The motors shown are Louis Allis vertical solid-shaft explosion-proof units designed for petroleum-pumping service. The smaller ribbed unit is a non-ventilated 1 hp. motor used to pump fuel to the plane; the larger unit is a 30 hp. fan-cooled transfer-pump motor.

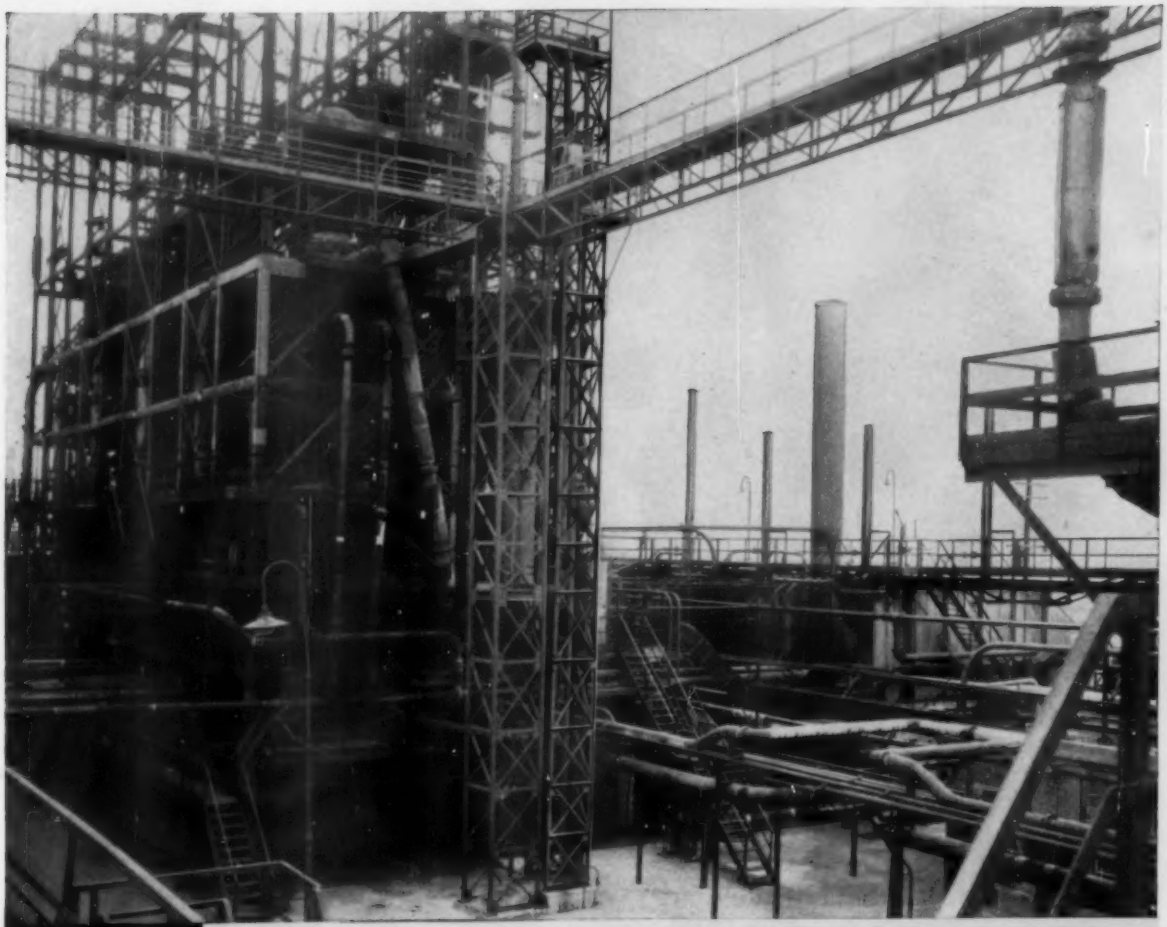
Both of these motors are weatherproof; they assure dependable service and long life under baking sun and in driving rain- or dust-storms. Louis Allis insulating varnish is sure protection against moisture or embrittlement, and sturdily resists even the effects of acids or alkalis in the extreme environmental conditions encountered in petrochemical service.

Locked bearings assure long bearing life, and a readily accessible thrust bearing makes infrequent maintenance quick and easy.

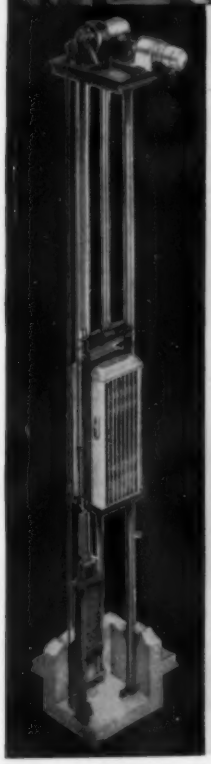
Get this dependability in *your* petroleum applications. Contact your Louis Allis District Office, or write The Louis Allis Co., 449 E. Stewart St., Milwaukee 1, Wis.

LOUIS ALLIS

MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES



A typical installation of an EHRSAM ELEVATOR at a Gulf Coast refinery.



Safe, Low Cost EHRSAM
ELECTRIC ELEVATOR FOR "CAT" CREWS

FACTS:
Complies with American Standard Safety Code, all state and local codes. Machinery and cab can be furnished galvanized for outdoor installation . . . lift rate, 90 ft. per minute. For special applications, speeds of from 50-120 ft. per minute are available.

SIZES:

2'3" x 2'3"	—	300 lb. capacity (1½ Hp.)
2'9" x 2'9"	—	500 lb. capacity (2 Hp.)
4' x 4'	—	1000 lb. capacity (3 Hp.)
4'6" x 6'	—	2000 lb. capacity (7½ Hp.)

Maximum lift 250 feet. All-metal car with collapsible door. Magnetic brake. Emergency exit and safety door. Rigid, electric-welded all-steel frame.

All components factory assembled and pre-tested for easy installation. Complete operating instructions and detailed drawings included with each unit. Furnished with all elevator safety equipment required by code. All electrical equipment can be furnished explosion proof for either 220 or 440 volts.

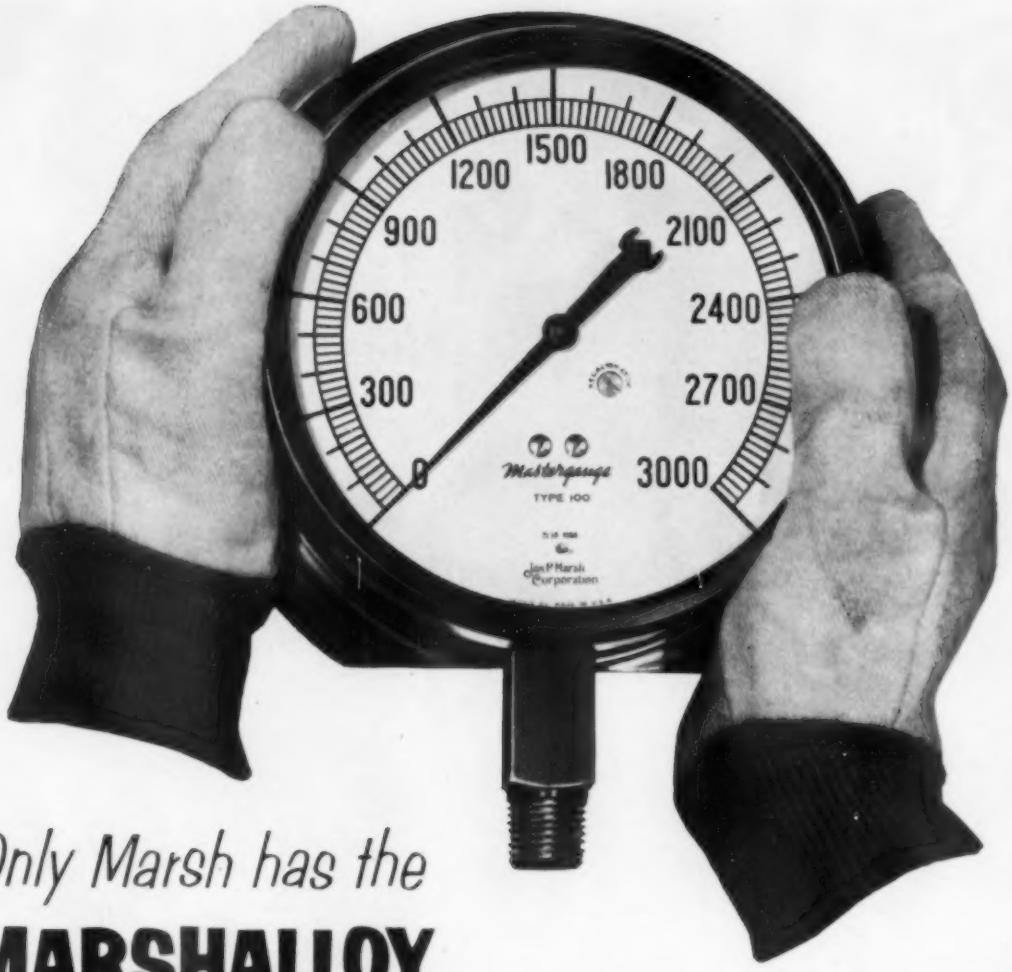
WRITE, WIRE OR PHONE FOR ILLUSTRATED BROCHURE AND LIST OF EHRSAM ELECTRIC ELEVATOR CUSTOMERS.

Push-button, car-type for 1 to 6 passengers.
Easy to run, inexpensive to operate, simple to install.

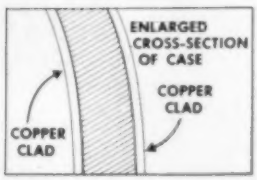
EHRSAM®

THE J. B. EHRSAM & SONS MFG. CO.
DEPT. OG, ENTERPRISE, KANSAS
"OVER 80 YEARS OF DEPENDABLE SERVICE"

SALES OFFICES: Denver, Colorado; Fort Worth, Texas; Kansas City, Kansas.
WEST COAST: Ehrsam Pacific, Inc., Riverside, California.



Only Marsh has the **MARSHALLOY CASE**



The strength of steel; the corrosion resistance of solid copper . . . that's the Marshalloy copper-clad case.

Four times stronger than cast iron
One-third lighter

There's nothing temperamental about a pressure gauge . . . provided it's built right and given proper protection. The basic units of Marsh Gauges—socket, tube and movement—are known for the care given to their manufacture. Such units deserve the best protection . . . and *get it* in the Marshalloy case. Here is a steel case of boiler-plate-thickness, heavily clad with copper inside and out . . . lighter, but many times tougher . . . protected against the ravages of corrosion. It is available only in Marsh Gauges.

MARSH INSTRUMENT CO. *Sales Affiliate of Jas. P. Marsh Corp.*
Dept. L, Skokie, Illinois

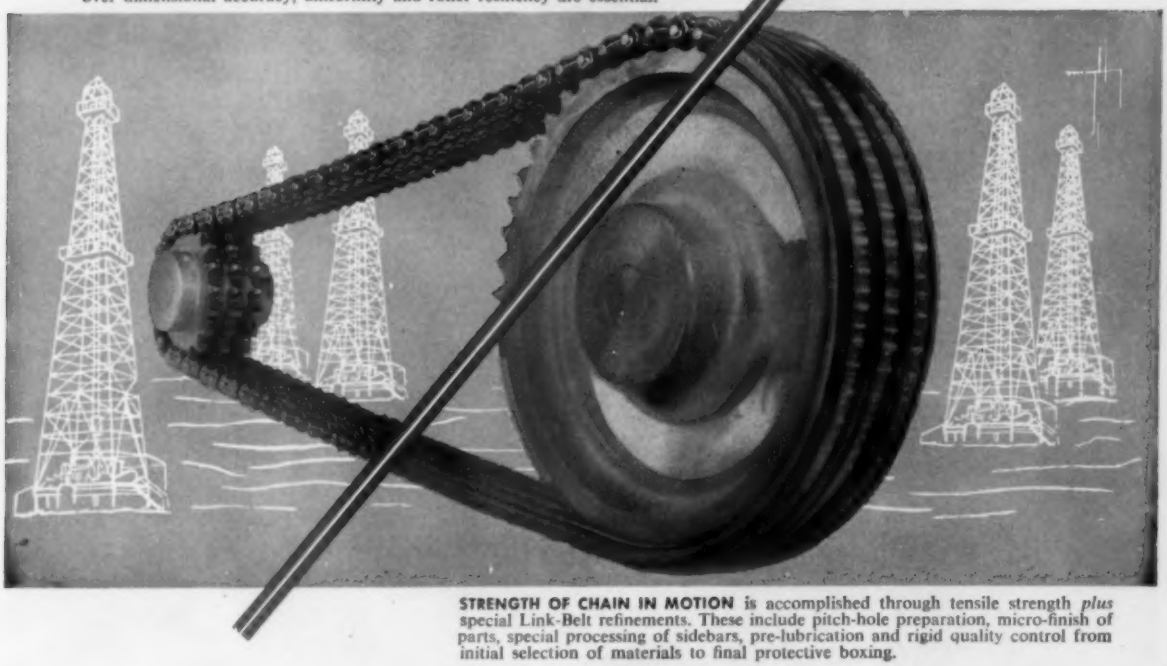
Marsh Instrument and Valve Co. (Canada) Ltd., 8407 103rd St., Edmonton, Alberta
Houston Branch Plant: 1121 Rothwell St., Sect. 15, Houston, Texas

MARSH GAUGES

PRESSURE GAUGES • THERMOMETERS • WATER REGULATING VALVES • HEATING SPECIALTIES

Not just static strength, but . . .

RESISTANCE TO TENSILE STRESS is achieved by use of properly heat-treated, accurately-machined sidebars made of premium steel and fitted with properly-hardened pins, bushings and rollers. But to resist *operational* stresses, additional controls over dimensional accuracy, uniformity and roller resiliency are essential.



STRENGTH OF CHAIN IN MOTION is accomplished through tensile strength *plus* special Link-Belt refinements. These include pitch-hole preparation, micro-finish of parts, special processing of sidebars, pre-lubrication and rigid quality control from initial selection of materials to final protective boxing.

dynamic strength

assures longer work-life for LINK-BELT Roller Chain

To MEET increasing demands for greater speed and depth, today's drives must be capable of taking terrific punishment. And *dynamic* strength—capacity of chain to resist severe operating stresses—is of vital importance.

That's why EXTRA dynamic strength is built into every length of Link-Belt Precision Steel Roller Chain. It's your assurance of lasting, efficient performance that shrugs off stresses due to engagement with sprockets, shock of starting, centrifugal loads.

Link-Belt develops exceptional dynamic strength by combining special methods of design, manufacturing and processing with proved "extras." Extras that pay off in reduced drilling costs and less down-time.

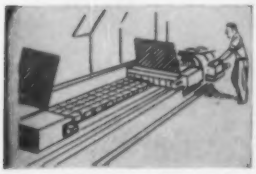
You can get full information at your nearby Link-Belt office or any leading supply store in the field. Ask for Book 2680, covering this complete line of single and multiple widths up to 3-inch pitch.

LINK-BELT

ROLLER CHAIN & SPROCKETS

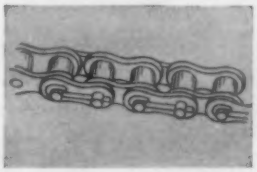
LINK-BELT COMPANY: Indianapolis 6, Houston 1, Dallas 21, Odessa, Tex., Shreveport, La., Los Angeles 33, Scarboro (Toronto 13); Export Office, New York 7. Distributors in All Fields. 14.304

LINK-BELT gives you dynamic strength that comes from these important EXTRAS

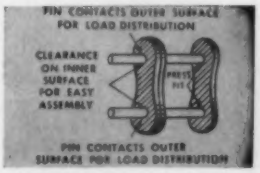


PRE-STRESSING of multiple width chain provides uniform load distribution.

SHOT-PEENED ROLLERS have greater fatigue life, added ability to withstand impact.



SHEPHERD'S CROOK COTTERS will remain in place under severe operating conditions.


PIN CONTACTS OUTER SURFACE FOR LOAD DISTRIBUTION
CLEARANCE ON INNER SURFACE FOR EASY ASSEMBLY
PRESS FIT
PIN CONTACTS OUTER SURFACE FOR LOAD DISTRIBUTION

FASTER COUPLING and uncoupling of multiple width chain with E-Z Assembly feature.

Behind the Ships that Set the Pace . . .
a Master's Touch in Oil

World's mightiest ship, the Navy's newest ocean-going airfield—U. S. S. Saratoga . . .

Maiden voyage of the world's first atomic-powered submarine . . .

All the Atlantic Blue Ribbon Winners, from the Mauretania to the S. S. United States . . .

World's fastest boat, 225 miles an hour—Donald Campbell's Bluebird . . .

Two-fifths of all the world's freighters . . .

The race horses and the work horses of the seas have one thing in common—SOCONY MOBIL'S *master touch* in lubrication.

Good reason! When the chips are down—when records are at stake—when schedules must be met—the men who know marine machinery look to SOCONY MOBIL for its protection.

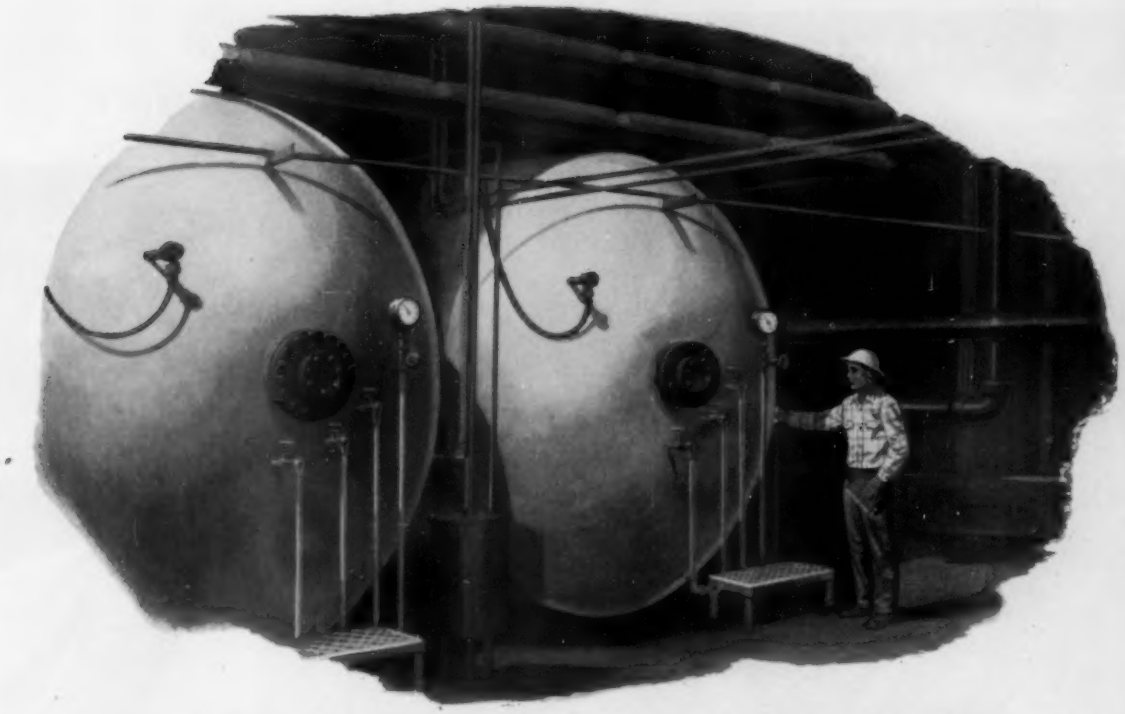
★ ★ ★

Wherever there's progress in motion—in your car, your ship, your plane, your factory, your farm or your home—*you, too, can look to the leader for lubrication.*

SOCONY MOBIL OIL COMPANY, INC.

LEADER IN LUBRICATION FOR 91 YEARS

Affiliates: General Petroleum Corporation, Magnolia Petroleum Company



cut chemical costs in half

with Aquaness desalting compounds

You'll save money, because Aquaness materials are concentrated. They're more economical to use, to ship, to store.

You'll eliminate trouble, because Aquaness materials work with a wide range of crudes. You don't need to switch chemicals or adjust feed rate when incoming crude varies in gravity and composition.

An Aquaness refinery representative will be glad to consult on your desalting process, to recommend an Aquaness compound that will give peak results in minimum amounts, and to supervise trials in your refinery to check performance. Write or call Aquaness today.

SAVES OVER $10,000 PER YEAR WITH AQUANESS COMPOUNDS

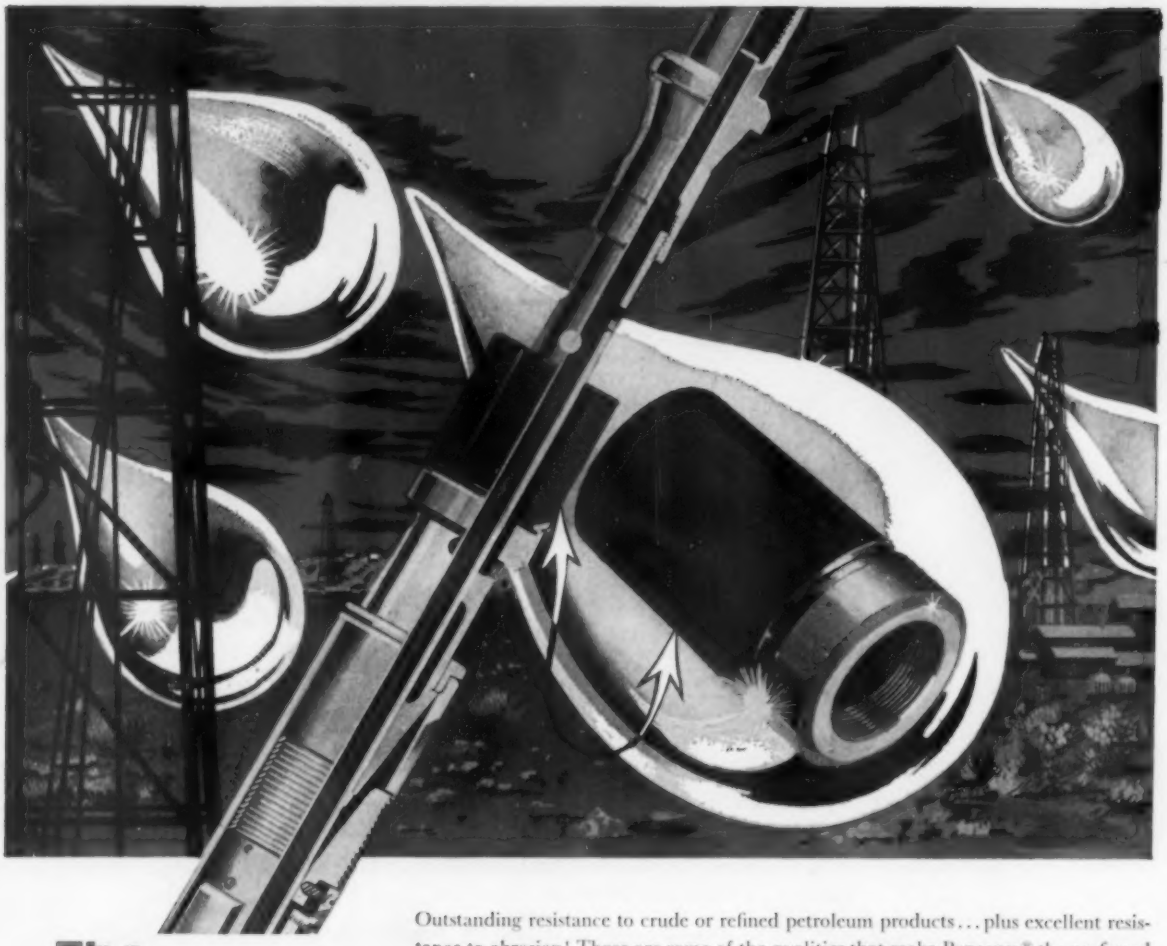
A leading refinery processing 8 different crudes at a total charge of 30,000 bbl/day has cut its desalting chemical cost by 52% by changing to concentrated Aquaness compound. Chemical savings amount to more than $10,000 per year.

Aquaness Department
ATLAS POWDER COMPANY
2005 Quitman Street, Houston 26, Texas

Chemicals for Refining, Gasoline Plants and Oil Transportation

Naugatuck PARACRIL

THE OIL-RESISTANT NITRILE-TYPE RUBBER



The RUBBER that gets along BEST with oil

Outstanding resistance to crude or refined petroleum products... plus excellent resistance to abrasion! Those are some of the qualities that make PARACRIL® the preferred rubber for the petroleum industry.

When a manufacturer's literature states that the rubber parts of drilling tools, inner tubes of oil hose, and seals or diaphragms for oil pumps are "made of special synthetic rubber that is resistant to oil, gas, acids and most other chemicals," it is describing the properties of PARACRIL.

A family of 10 different types of PARACRIL nitrile rubber—3 of them new "cold" types—now offers manufacturers the widest range of physical properties... plus oil resistance! Whether you are a manufacturer or user, insure *maximum satisfaction* by specifying PARACRIL for all rubber goods used in direct contact with petroleum oils, greases or distillates.

Naugatuck Chemical

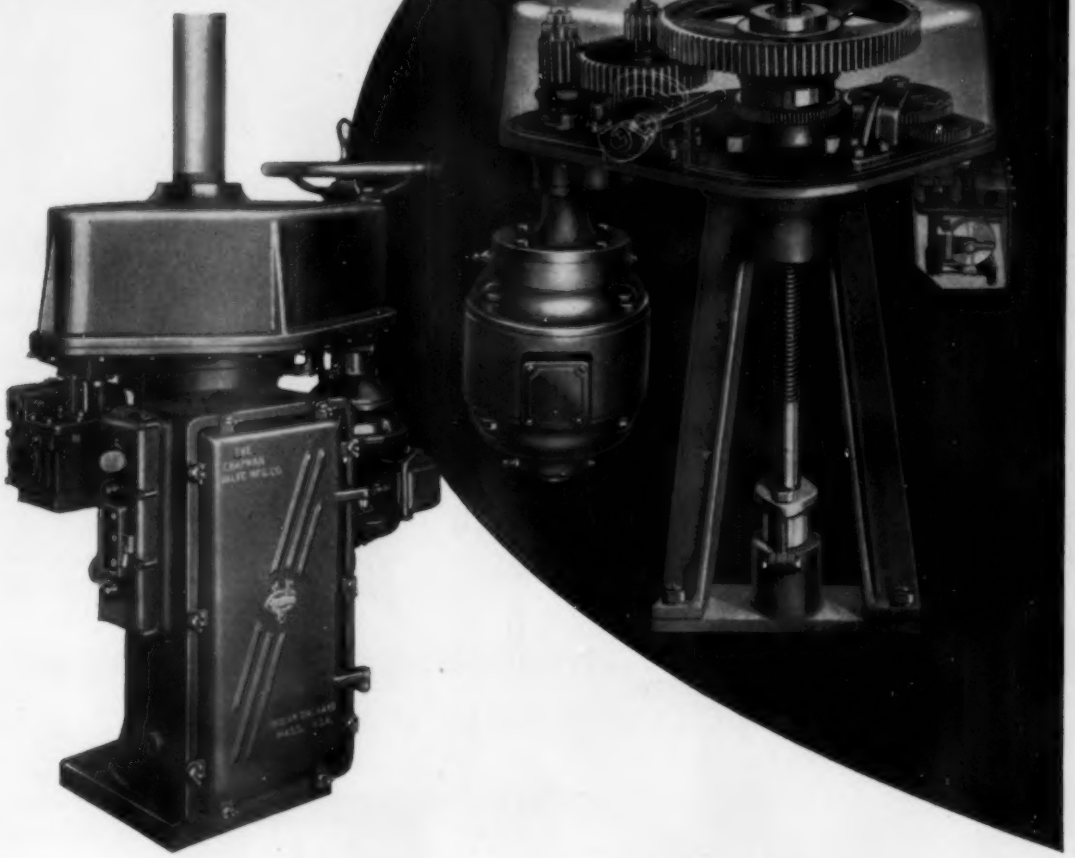
Division of United States Rubber Company
Naugatuck, Connecticut

US RUBBER

IN CANADA: NAUGATUCK CHEMICALS, Elmira, Ontario • Cable Address: Rubexport, N.Y.
Rubber Chemicals • Synthetic Rubber • Plastics • Agricultural Chemicals • Reclaimed Rubber • Latices

The Inside Story of
CHAPMAN
Motor Units

For Valves, Floorstands and Sluice Gates



The exposed view gives you the facts. On a Chapman Motor Unit there are approximately half as many parts as with any other make. This is engineering sense. The fewer the parts the fewer the headaches. The less complicated the unit the less you pay for maintenance.

This simplification in design is all on your plus side. You lose nothing in performance. In fact you get smooth accurate performance over a *longer* period of time. There's no drift. Backlash is low. And seat tightness is held at any predetermined level by precise micrometer-controlled limit switch.

Installation is easy and economical. When used with floorstands they come completely wired at factory . . . ready for your line. They're weatherproof. They're *steam tight*. And they operate at any angle. Rugged stub-tooth gears require no grease or oil.

See our Catalog 51, now. If you've misplaced your copy write for a new one, today.

THE CHAPMAN VALVE MANUFACTURING CO.
INDIAN ORCHARD, MASSACHUSETTS

VALVES

to control anything but rain!

My Boss buys a lot of valves — or has it done — and he sure likes to buy them from J&L Supply.

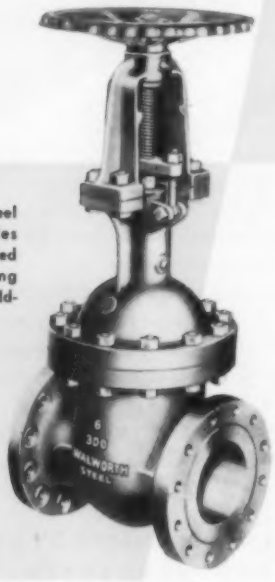
"Give those people the facts," says he, glancing at my new raincoat, "and they'll come up with the perfect valve for handling anything but rain."

"And what do we mean by the 'facts'?", says I, eager to be a good secretary.

"Oh," says he tolerantly, "to get the perfect valve for exacting jobs, we just give J&L complete service information: size and flange rating and facing, fluid to be handled, operating pressure, maximum temperature, any special corrosive conditions — that sort of thing."

"Oh?" says I.

"Young lady," says he, sensing my confusion, "don't expect to learn all about valves in a day. J&L Supply usually recommends Walworth, and Walworth was making and improving valves before your great granddaddy was born!"



Walworth Cast Steel Gate Valve, Series 300. Can be supplied with Roller Bearing Yoke and Butt Welding End.

29-G

Jones & Laughlin

SUPPLY DIVISION – Tulsa

SERVING THE UNITED STATES AND CANADA

Think you'll ever need
A-power fittings like these?

TUBE-TURN* Stainless Steel Elbows—heavy wall thickness for nuclear energy reactor.

Name your piping problem...
TUBE TURNS CAN HELP YOU!

No matter what kind of welded piping system you build . . . here's how Tube Turns can be of help:

Tube Turns' line includes 12,000 *standard* welding fittings and flanges, plus thousands of *specials* such as the A-power fittings shown above. When you buy from this *complete-line* leader, you get what you need *promptly* . . . products of unsurpassed *quality* . . . backed by experienced *engineering service* . . . for reliable, *low-cost piping*. Order from your nearby Tube Turns' Distributor.

*"TUBE-TURN" and "tt" Reg. U.S. Pat. Off.

The Leading Manufacturer of Welding Fittings and Flanges

TUBE TURNS LOUISVILLE 1, KENTUCKY

A Division of National Cylinder Gas Company

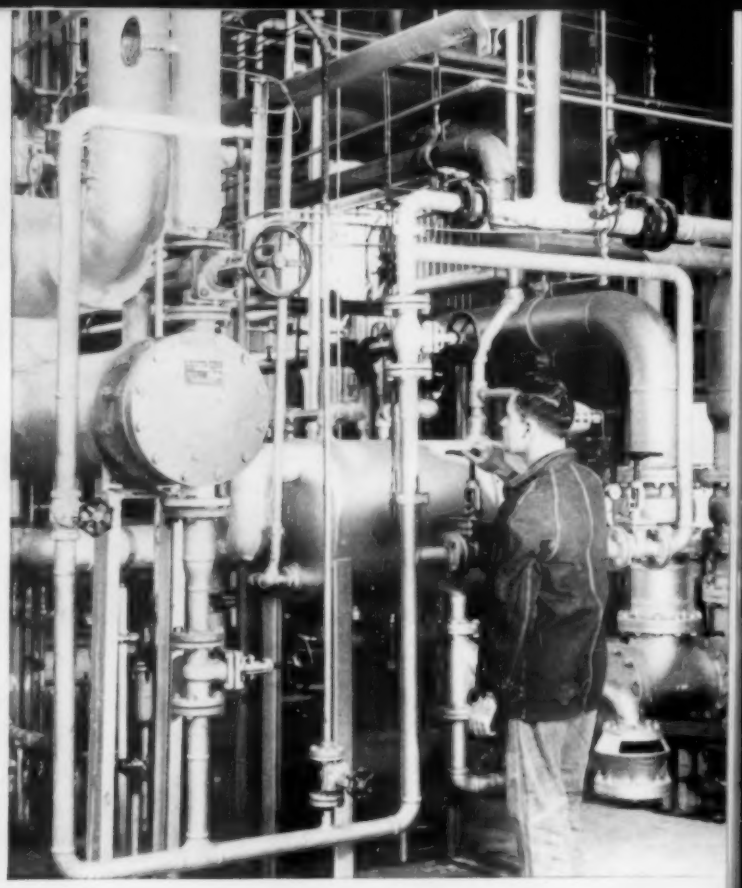
DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Chicago • Detroit • Atlanta • New Orleans • Houston • Midland Dallas • Tulsa • Kansas City • Denver • Los Angeles • San Francisco • Seattle

In Canada: Tube Turns of Canada, Ltd., Ridgetown, Ontario • Toronto, Ontario • Edmonton, Alberta

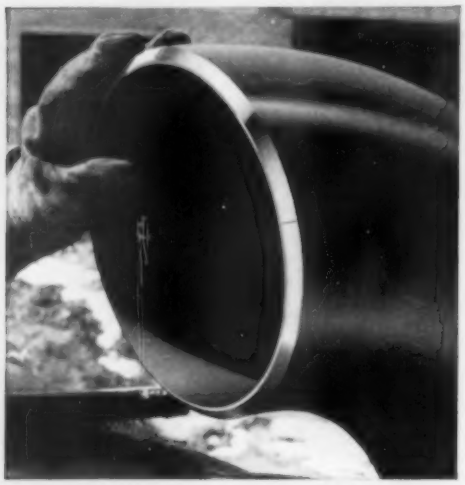
HOW YOU SAVE

12,000 "TUBE-TURN" PRODUCTS

to help you save 3 ways...



SIMPLIFIES ENGINEERING. There's no compromise when you specify TUBE-TURN products. You can count on getting the exact fittings for your project ...the right type, size, schedule and material for every piping service. Shown at right: Aluminum piping with TUBE-TURN Welding Fittings and Flanges, in water purification plant of The General Tire & Rubber Company, Chemical Division, Ashtabula, Ohio.



SPEEDS UP THE JOB. Uniform size, circularity, wall thickness of TUBE-TURN Welding Fittings assure good fit-up and alignment . . . help make piping installation work faster. Each fitting is marked with *complete* specifications for quick, accurate identification. Quartermarked bevels simplify fabrication.

ONE-ORDER PURCHASING. Your nearby Tube Turns' Distributor provides this complete-line service promptly. Hence, you can make *one order* fill all your needs in welding fittings and flanges . . . to cut red tape and save purchasing time.

HELPFUL DATA. New Tube Turns' booklet gives information on pipe, fitting and flange materials. Mail coupon for your free copy.

TUBE TURNS, Dept. J-3
224 East Broadway, Louisville 1, Kentucky

Please send free copy of Pipe, Fitting and Flange Materials.

Company Name _____

Company Address _____

City _____ *Zone* _____ *State* _____

Your Name _____

Position _____

Available from your nearby TUBE TURNS' distributor

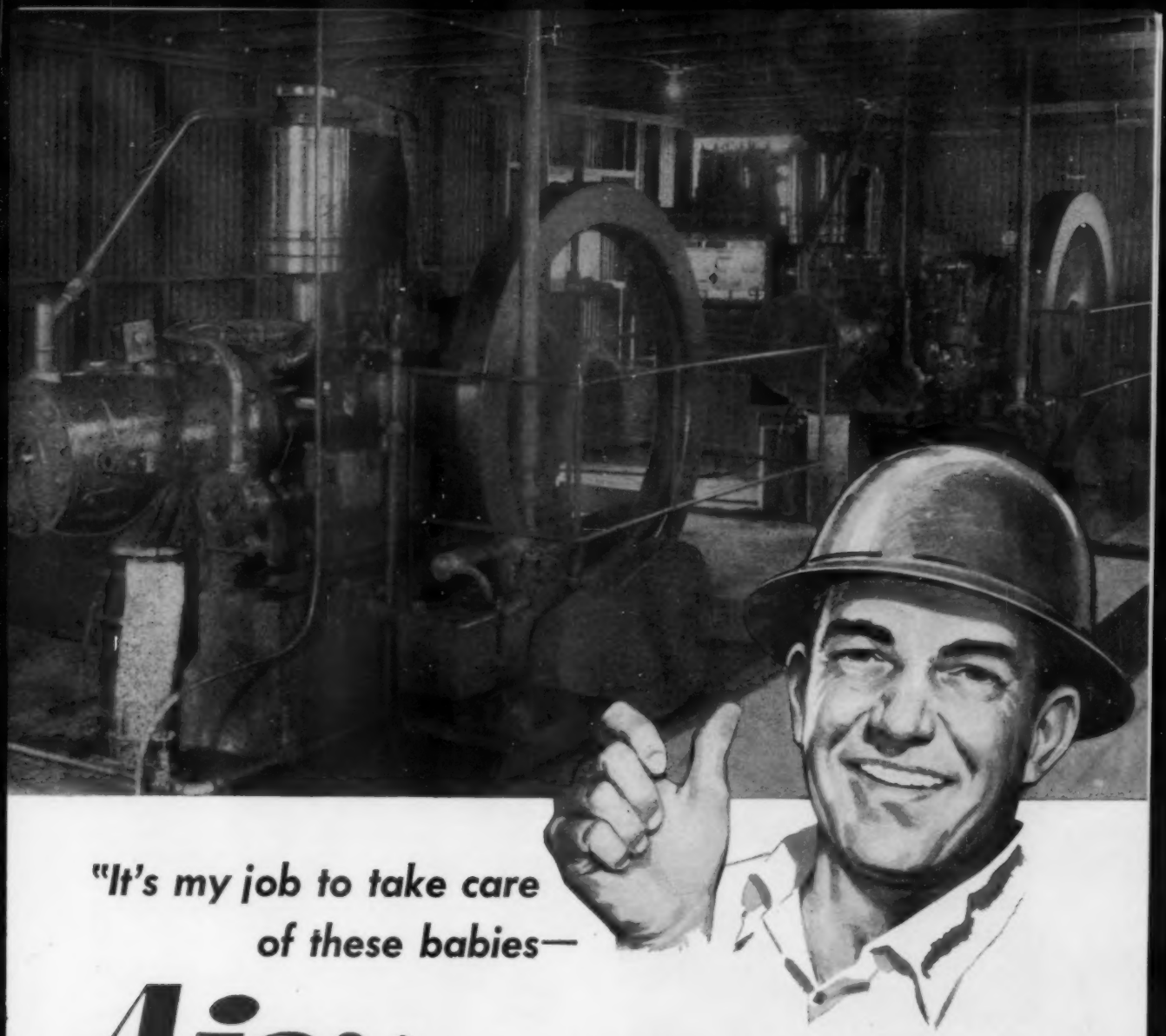
"TUBE-TURN" and "tt" Reg. U.S. Pat. Off.

TUBE TURNS

LOUISVILLE 1, KENTUCKY

A DIVISION OF NATIONAL CYLINDER GAS COMPANY

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Chicago Detroit • Atlanta • New Orleans • Houston • Dallas • Midland Tulsa • Kansas City • Denver • Los Angeles • San Francisco • Seattle
In Canada: **Tube Turns of Canada Limited, Ridgetown, Ontario Toronto, Ontario • Edmonton, Alberta**



"It's my job to take care of these babies—

—Ajax SURE MAKES IT EASY FOR ME!"

We build Ajax Gas Engines and Pressure Pumps so that they need almost no attention. *Feed 'em and smile at 'em,* we like to say—*they'll do the rest.*

• Fact is, of course, all fine equipment calls for a good man to care for it. Our point is that AJAX products ask for the minimum of service, over the longest working periods, and are the easiest to handle in any man's experience.

Ask your Supply Man!

AJAX

- **GAS ENGINES**
- **PRESSURE PUMPS**

AJAX IRON WORKS

Builders of GAS AND OIL ENGINES, PRESSURE PUMPS, STEAM DRILLING ENGINES, INDUSTRIAL STEAM ENGINES

CORRY, PENNSYLVANIA

Oil Field Distributors: THE NATIONAL SUPPLY CO., PITTSBURGH, PA. R. B. MOORE SUPPLY CO., BOLIVAR, N.Y. • BETHLEHEM SUPPLY CO., TULSA, OKLAHOMA

FOR OIL INDUSTRY ENGINES • • • •

Better to Start with—
Best in the Long Run!

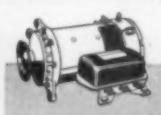
AMERICAN BOSCH
MAGNETOS

Steadily improved electrical and mechanical characteristics give these famous Magnetos greater power, PLUS the traditional built-in stamina that assures *years* of constant, trouble-free ignition in Drilling, Pumping, and Pipe line engines. This is why these power-packed Magnetos are so steadily used as original equipment by so many leading engine builders.

On all your present equipment, with either high or low tension ignition systems, you can have this instantaneous spark efficiency and matchless dependability at all engine operating speeds and loads. For, there's an American Bosch Magneto replacement precisely engineered for the largest, heavy-duty engine, right down to the most modern, high-speed power unit. Moreover, American Bosch can serve you well through one of the largest and most efficient field service organizations. There's an AB Service Agency near you. Write to us today for Magneto replacement application data on your high or low tension engines. American Bosch, Springfield 7, Mass. A Division of American Bosch Arma Corporation.

AMERICAN BOSCH

Automotive and Aviation Magnetos


Generators and Regulators

Components for Aircraft Engines

AMERICAN BOSCH

Small Electric Motors

Electric Windshield Wipers

Diesel Fuel Injection Equipment

Stems can't seize...

BRONZE TRIM FIG. 333

ALL-IRON TRIM, FIG. 337

Both of these OIC Duo-Bolt gates have special stems. The Fig. 333 stem is OIC *Alloy-40* in sizes 2″ and under . . . corrosion-resistant bronze with 20 to 30 times longer life than most other stem bronzes. It will not gall or seize. In fact, this alloy has all but eliminated stem replacement. The Fig. 337 stem is nickel-plated steel . . . highly resistant to pitting in the packing area, sturdy and long wearing.

Design includes bonnet drain ducts . . . recessed gasket seat

To protect against freezing, bonnet ducts allow complete drainage of the upper part of the valve. The male-female, gasketed body-bonnet connection assures a tight joint and prevents blown gaskets.

Exclusive cast-in seat rings

On sizes 2″ and under, bronze trimmed valves include cast-in seat rings, *rolled* to make doubly sure that they cannot loosen in service. On sizes 2½″ and larger, seat rings are screwed in. Seats are integral on all-iron trim valves. Both types include a button-head stem-to-wedge connection, flexible for non-binding wedge seating.

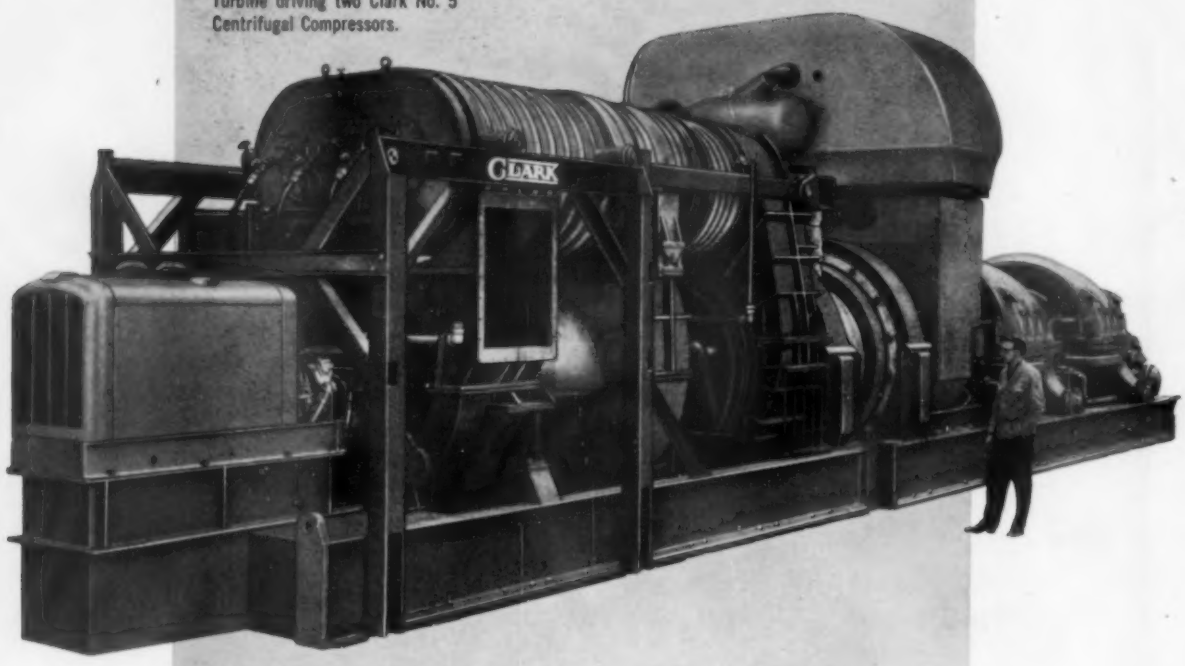
Immediate availability . . . long line

Order Duo-Bolt gates from your OIC Distributor or his field store. Sizes: ¼″ to 4″, screwed or flanged ends. Working pressures: 125 to 150 lbs. WSP, 200 to 225 lbs. cold WOG, non-shock. Request Form No. 1007 for more information.

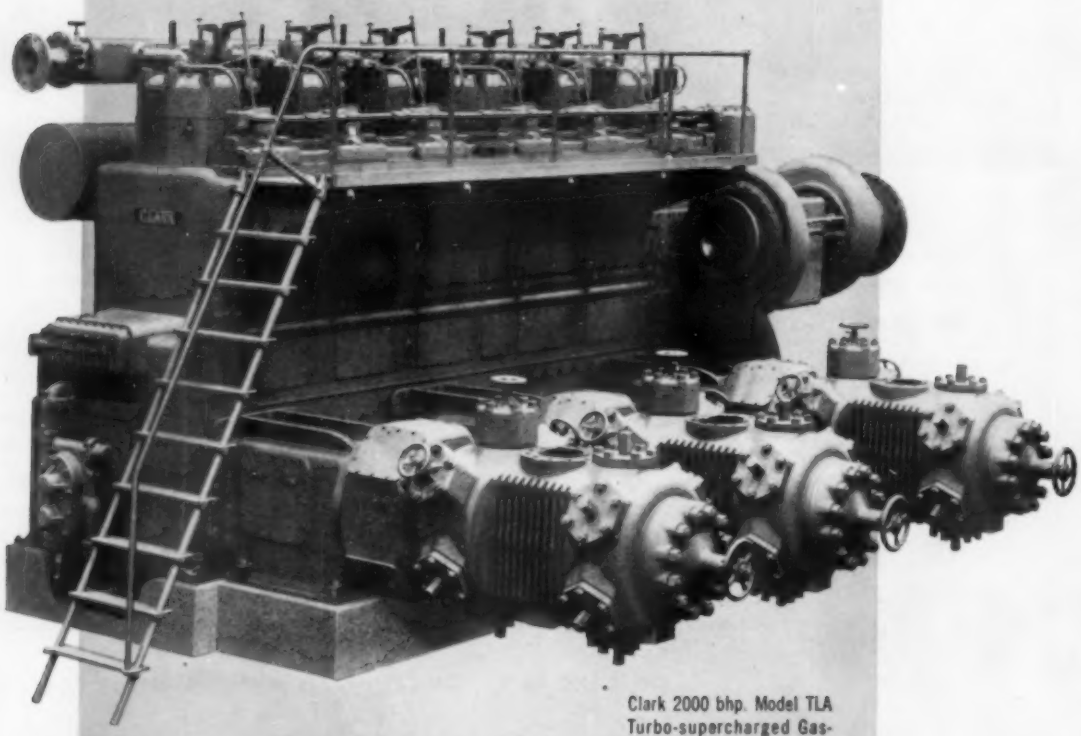
THE OHIO INJECTOR COMPANY • WADSWORTH, OHIO

VALVES | **FORGED & CAST STEEL, LUBRICATED PLUG, BRONZE & IRON VALVES**

P-509



Clark 8500 bhp. Model 302 Gas Turbine driving two Clark No. 5 Centrifugal Compressors.



Clark 2000 bhp. Model TLA Turbo-supercharged Gas-Engine-Driven Compressor.

Gas turbines or engines?

With Clark you eliminate

Prejudice

Gas turbine-driven centrifugal compressors or reciprocating compressors . . . you can get both types from Clark

Prejudice can add substantially to the cost when selecting compressors. At Clark, we build both gas turbine-driven centrifugal compressors and gas-engine-driven reciprocating compressors. In both instances the compressors and drivers are the most modern available.

Our chief concern is to be certain that you obtain the proper unit for your specific installation. This is where our experienced application engineers enter the picture. Both types of units have certain characteristics that may make one or the other best for your particular use. An unbiased opinion, after a careful examination of all the facts and conditions, is vitally important. Clark is the only company that can give you an unbiased opinion because Clark is the only company that builds reciprocating and centrifugal compressors in addition to gas turbines.

Clark application engineers will be pleased to help you determine the right type of compressor and driver combination for your next application.

CLARK BROS. CO., OLEAN, NEW YORK

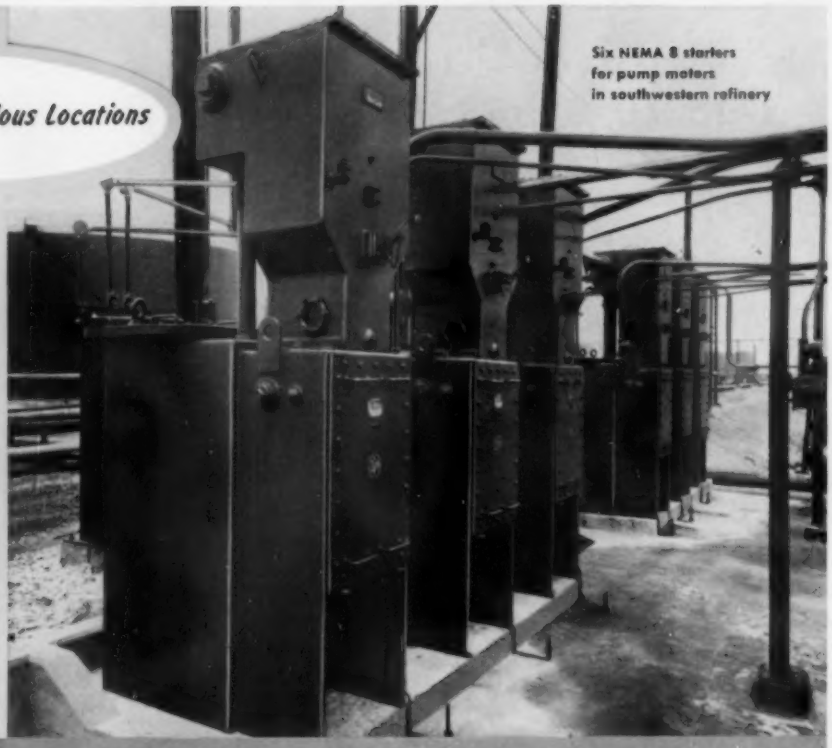
One of the Dresser Industries

Offices in Principal Cities Throughout the World

CLARK®

Centrifugal Compressors
Reciprocating Compressors
Gas Turbines

for Class 1, Group D, Hazardous Locations

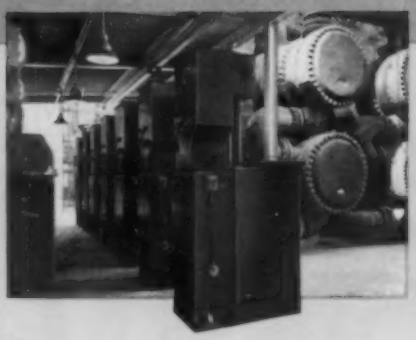


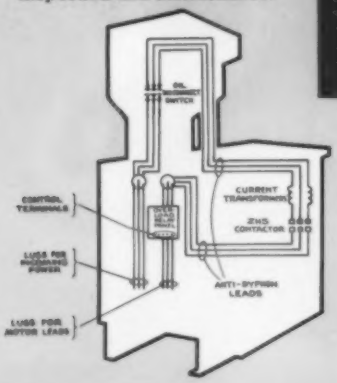
Six NEMA 8 starters for pump motors in southwestern refinery

here's how to

SAVE SPACE and INSTALLATION TIME with EC&M HIGH VOLTAGE STARTERS

SPACE SAVERS! Each of the seven starters in the eastern refinery installation *(at the right)* requires a space of only 2 ft. x 4 ft.—permitting close grouping with maximum accessibility for inspection and maintenance.





YOU SAVE INSTALLATION TIME because every ECaM starter is shipped with all internal wiring complete. *(See diagram at left)* All leads are of anti-syphon construction.

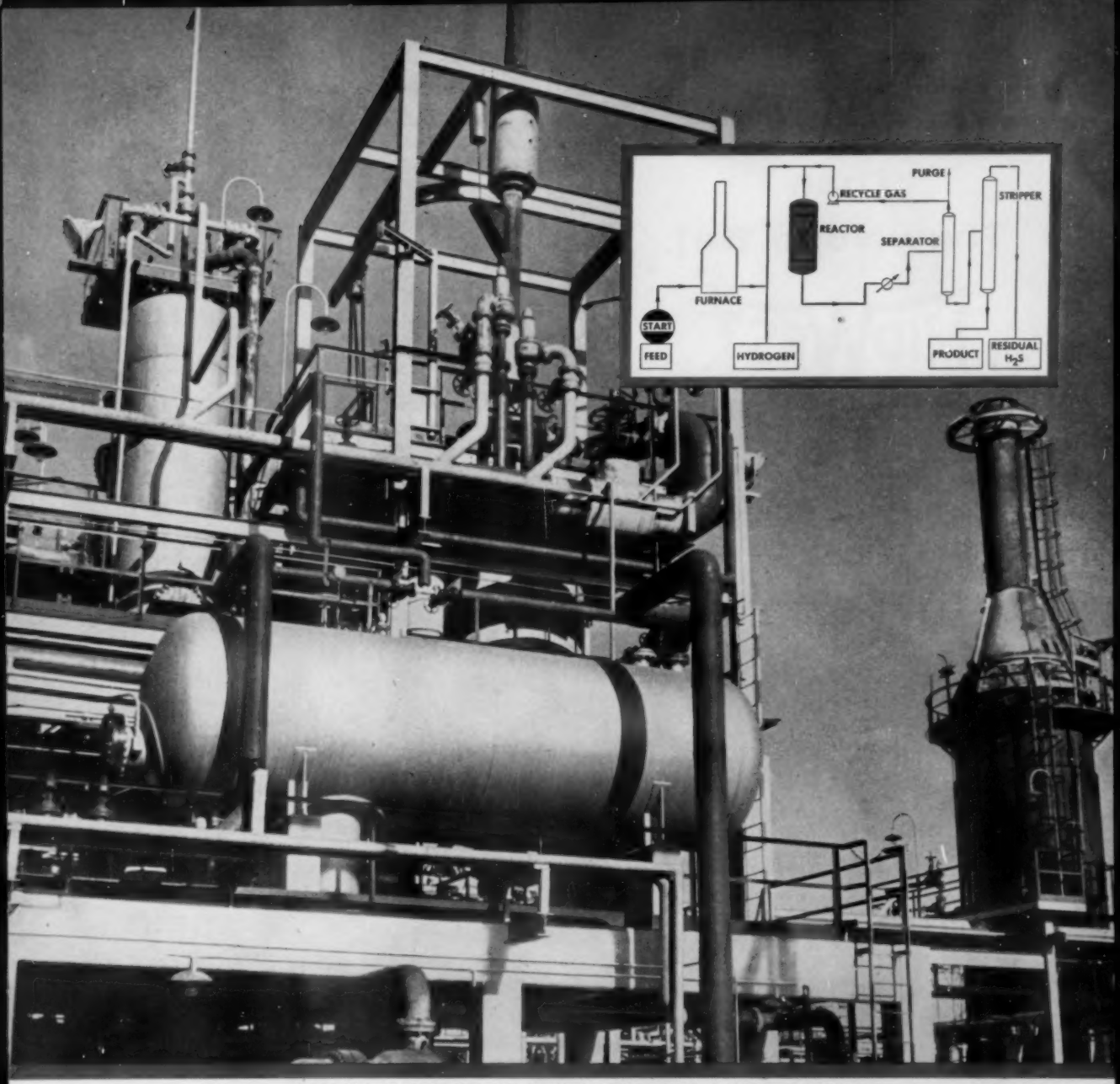
Write for Bulletin 8131 AM

These ECaM 2200-4800 volt Starters are designed for use where hazardous mixtures of air and inflammable gases or vapors are ever-present. NEMA 3R (raintight) enclosure permits mounting indoors, outdoors, or in semi-enclosed location. Load-break oil disconnect switch is self-contained and completely wired into the starter.

Available in two ratings for any power capacity. (*1*) 50,000 KVA (certified) interrupting capacity of ECaM Type ZHS Contactor. (*2*) In VALIMITOR® (volt-ampere-limitor) style... the bus may be of unlimited capacity.

THE ELECTRIC CONTROLLER & MFG. CO.
A DIVISION OF THE SQUARE D COMPANY
CLEVELAND 28 • OHIO

7936



19,500 B/D CRACKED HEATING OIL HYDROFINER, ESSO STANDARD'S BAYWAY REFINERY, LINDEN, N. J.

HYDROFINING CAN GIVE YOU TOP PERFORMANCE AT LOWEST INVESTMENT

Esso Research and Engineering offers you *Hydrofining*, a process now being applied to a greater variety of feed than any other hydrogen-treating process. *Hydrofining* uses by-product hydrogen to remove sulfur and other impurities *without yield loss.*

The process improves product stability, odor, color and other quality characteristics without the disadvantages of chemical or clay treating methods. *Hydrofining* is another achievement of the Esso Research program — 38 years of new process developments made available to refiners around the world.

Hydrofining experience has been gained from commercial units processing a wide variety of feed stocks such as naphthas, distillate fuels, lubes and waxes. This experience plus years of hydrogenation research gives us a unique opportunity to recommend the best design for your plant.

Twenty-three *Hydrofining* installations are on stream; eight more are in the construction or planning stage. Licensees enjoy benefits of continuing *Hydrofining* research. *Hydrofining* can play an important part in helping you process previously unattractive stocks into higher quality products. We would welcome your inquiry.

ESSO RESEARCH AND ENGINEERING COMPANY

15 West 51st Street, New York 19, N. Y.

Your key to progress... an Esso Research process

Always Stronger Than They Need Be!

MIDWEST

WELDING FITTINGS

Below are photographs of two of the many tests that have been made of Midwest Welding Fittings. The results are *always* the same . . . the seamless pipe to which the fittings are welded invariably bursts. There is *never* any sign of fitting failure or weakness.

There's good reason for this. We make elbows and tees of inherently stronger metal . . . the Midwest exclusive method of manufacture enables us to maintain greater minimum wall thickness, and to reinforce the fittings at points of greatest stress. For the many other advantages of Midwest Fittings, ask your Midwest distributor or write us for Catalog 54.

MIDWEST PIPING COMPANY, INC.

Main Office: 1450 South Second St., St. Louis 4, Mo.

PLANTS: ST. LOUIS, CLIFTON, N. J. and LOS ANGELES

SALES OFFICES:

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MIAMI 34—2103 LE JEUNE RD. • NEW YORK 7—50 CHURCH ST.
ONEIDA, N.Y.—282 NORTH MAIN ST. • SAN FRANCISCO 11—420 MARKET ST.

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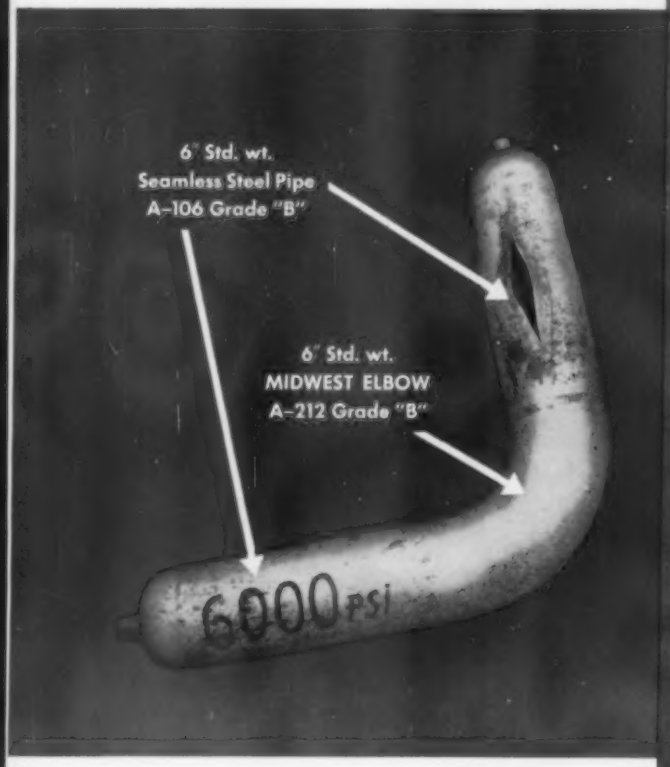


Typical bursting test of stock Midwest Welding Elbow. As is always the case, failure occurred in the seamless pipe while the elbow was undamaged. Bursting pressure was 6000 psi . . . considerably above the required code minimum for seamless pipe. (Minimum allowable bursting pressure for 6" standard weight A-106 Grade B seamless steel pipe is 4438 psi.)

Bursting test of Midwest Welding Tee taken at random from stock. As always, the failure occurred in the seamless pipe and not in the fitting. The non-shock internal bursting pressure of 6200 psi is well above the code minimum for seamless pipe. (Minimum allowable bursting pressure for 6" standard weight A-106 Grade B seamless steel pipe is 4438 psi.)

7761

MIDWEST **WELDING FITTINGS IMPROVE PIPING DESIGN AND REDUCE COSTS**

STOP —off lines...

but maintain flow!

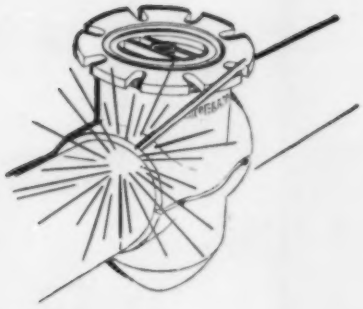
The **MUELLER** *No. 3 Line Stopper Unit*

When repair, replacement or a tie-in is necessary on a 6" or 8" line, a Mueller No. 3 Line Stopper Unit can shut-off the line under pressure, yet service need not be interrupted.

Line Stopper Fittings and Drilling Nipples are welded to the pipe and gate valves attached. The pipe is cut by a C1-36 or CC-36 Drilling Machine and a by-pass line installed. The Line Stopping Machine inserts and expands a stopper which safely isolates the section of pipe to be worked on. When work is completed, the by-pass is removed, fittings capped, and normal operations are resumed.

Flow is maintained without a minute's interruption. The line is under pressure through every step of work, but there is *no* escape of fluid, *no* reduction of safety!

Stop off those lines that need attention, but keep flow on the go – get the details on Mueller NO-BLO® Line Stopping Equipment from your Mueller Representative or write direct.



NO-BLO®

Unit No. 3, for 6" and 8" lines, consists of two H-17335 Stopping Machines, one H-17345 Completion Machine and one set of attachments. Max. pressure: 60 p.s.i.; max. temperature: 250°F.

Unit No. 3SW, for 6" and 8" lines, with two H-17340 Stopping Machines, one H-17346 Completion Machine and one set of attachments is used for higher pressures. Max. pressure: 230 p.s.i. at 100°F.; max. temperature: 250°F. at 200 p.s.i.

MUELLER CO. **DECATUR, ILL.**

Factories at: Decatur, Chattanooga, Los Angeles; In Canada: Mueller, Limited, Sarnia, Ontario

MUELLER CO. 100th YEAR SERVING the Water and Gas Industries QUALITY

Since 1857

NOW . . . you can fill casing from bottom more efficiently than ever!

RECTOR Type "O" Fill Shoe and Fill Collar

Used in conjunction with each other, Rector Type "O" Fill Shoe and Fill Collar provide an automatic constant fill; increase operating flexibility while running casing and during cementing operations. They reduce running time, increase safety, efficiency and economy and minimize the danger of sticking pipe.

RUNNING TIME REDUCED because manual fill is eliminated.

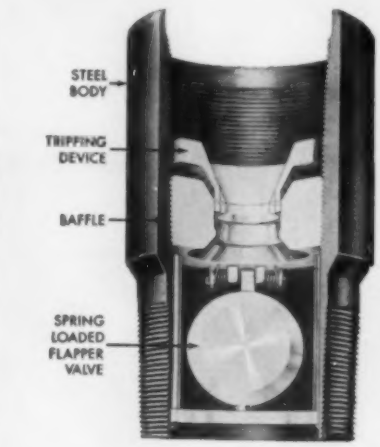
PIPE STICKING MINIMIZED because no "stops" are required to fill from top.

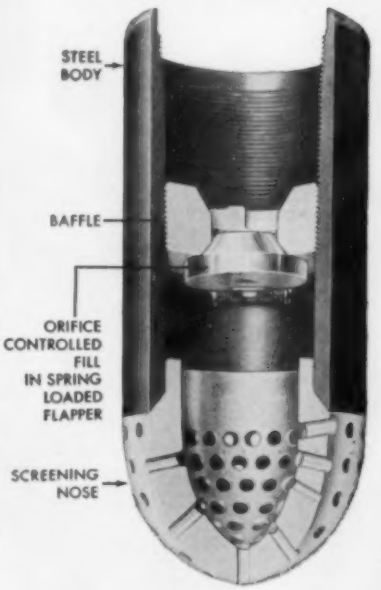
REDUCES PRESSURE SURGE and danger of breaking-down formations, causing lost circulation and loss of drilling fluids.

UNRESTRICTED PASSAGE OF FLUID permits greater volumes through shoe and collar at reduced pump pressures with higher velocity in annulus.

ORIFICE FILL AFTER CIRCULATION. You can stop and circulate as often and long as desired with continued orifice fill when running is resumed.

CONVERTS TO FLOAT WHEN DESIRED, by tripping flapper valve in collar which provides positive closure.





• Internal parts of both shoe and collar are a special aluminum alloy which has greater strength and abrasion resistance, plus easier and faster drill out.

The Type "O" Fill Shoe has a perforated aluminum alloy nose and baffle which is equipped with spring-loaded flapper valve with orifice choke. Orifice inserts are available in various choke diameters engineered for all pipe sizes.

The Type "O" Fill Collar has an aluminum alloy baffle, spring-loaded flapper valve and shear pin assembly for holding valve open. It functions as a back pressure valve or float collar. The flapper valve can be closed at any time by dropping a trip ball in casing at surface. At 650 p.s.i. pump pressure the ball releases flapper valve to provide a positive closure. Ball gravitates, or is pumped into nose of shoe.

If casing is run to total depth with orifice fill, ball is not used. Seating of cement plug on fill collar releases and closes flapper valve which then acts as back pressure valve, providing positive flow-back control.

RECTOR WELL EQUIPMENT COMPANY INC

★ MAKING THE OIL INDUSTRY SAFER ★

1100 NORTH COMMERCE ST., FORT WORTH, TEXAS

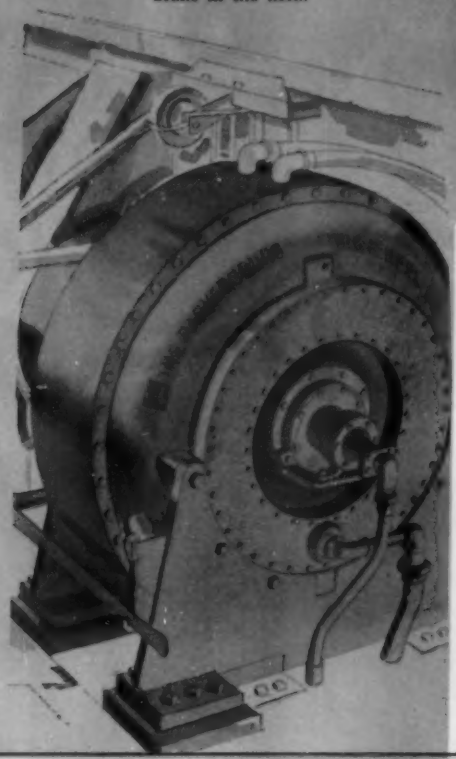
Houston Plant: 3213 Commerce St.

REPRESENTATIVES IN ALL ACTIVE FIELDS

60th Anniversary

These Parkersburg "FIRSTS" spelled PROGRESS for the Petroleum Industry

1929 – Parkersburg Rig and Reel Company was the first to offer a drawworks brake that made deep drilling possible. The Hydromatic brake is still the most successful and safest brake in the field.



Consider the importance of these equipment developments by Parkersburg Rig and Reel Company to the petroleum industry:

1899 – First application of chain drive to oil field equipment

1899 – First bolted wooden derrick that could be dismantled and moved to new location

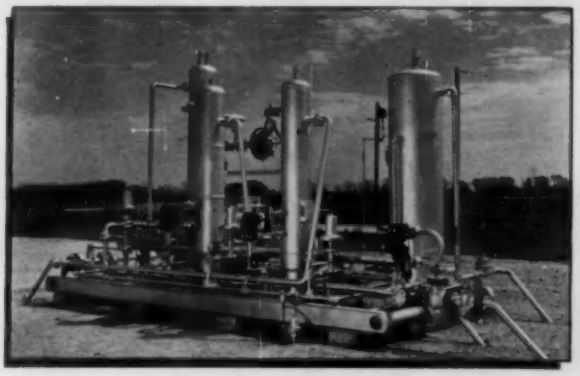
1929 – First steel substructure for drilling rigs, a development that led eventually to unitized and portable rigs

1949 – First single tube oil and gas separator

1949 – Hydracepter was first successful means of removing free water from high pressure gas lines and recombining liquid hydrocarbons with gas stream

1955 – First Dynamic Adsorption Unit (DAU) for dry desiccant adsorption at wellhead

1925 – The first long-stroke pumping unit was introduced by Parkersburg. The longer, slower stroke lifted more oil and materially reduced wear and fatigue on sucker rods. Parkersburg long stroke pumps have been first choice with producers for 32 years.

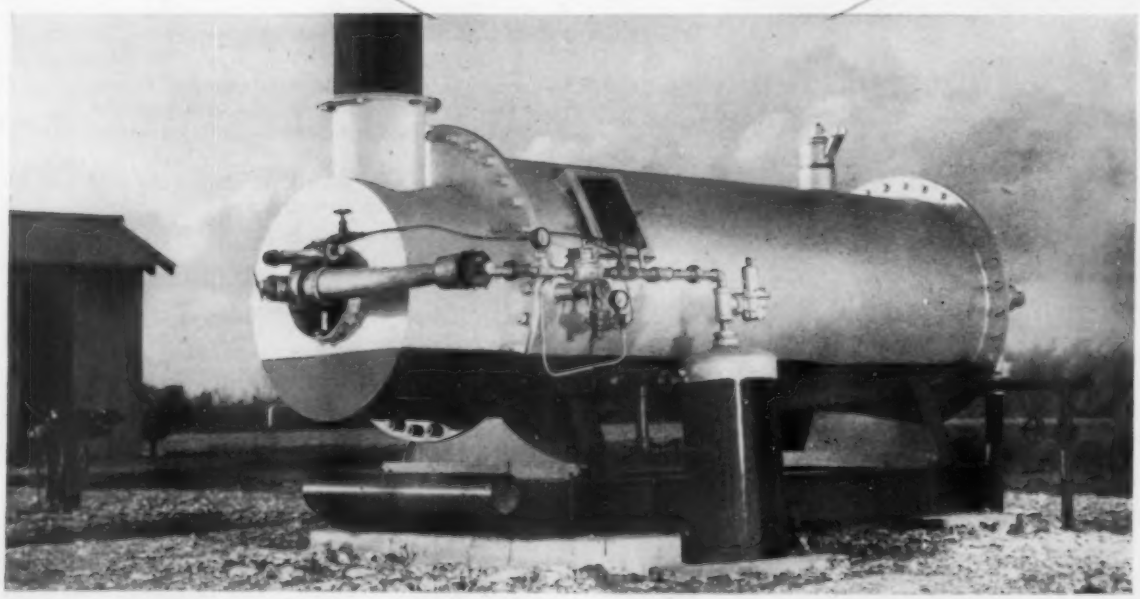


1950 – The first successful cold separation unit, the Hyreco, appeared under the familiar Parkersburg trademark. Operators found that the Hyreco gave more condensate recovery than any other unit. Hyrecos are now landmarks in high pressure areas.

And now – in Observance of Our 60th Anniversary –
Parkersburg Offers Further Proof of Its Leadership
in Pioneering Equipment to Meet Specific
Needs of the Petroleum Industry.

1 A Parkersburg 60th Anniversary FIRST

Get Trouble-Free Operations with a NEW Parkersburg Indirect Heater equipped with a STORM-PROOF Burner and Pilot...



The new jet type burner and pilot on Parkersburg indirect heaters assure you of complete combustion at maximum "blue flame" efficiency. Because fuel gas mixes automatically with the correct amount of air, your Parkersburg indirect heater will operate even under storm conditions. And it is simple to operate. With the primary air knob wide open, a simple turn of the positive-seat valve on the fuel gas line controls the amount of fuel gas as desired – and the correct air mixing is simultaneously adjusted by the burner itself.

This 60th Anniversary development by Parkersburg means safety and economy in your lease heating.

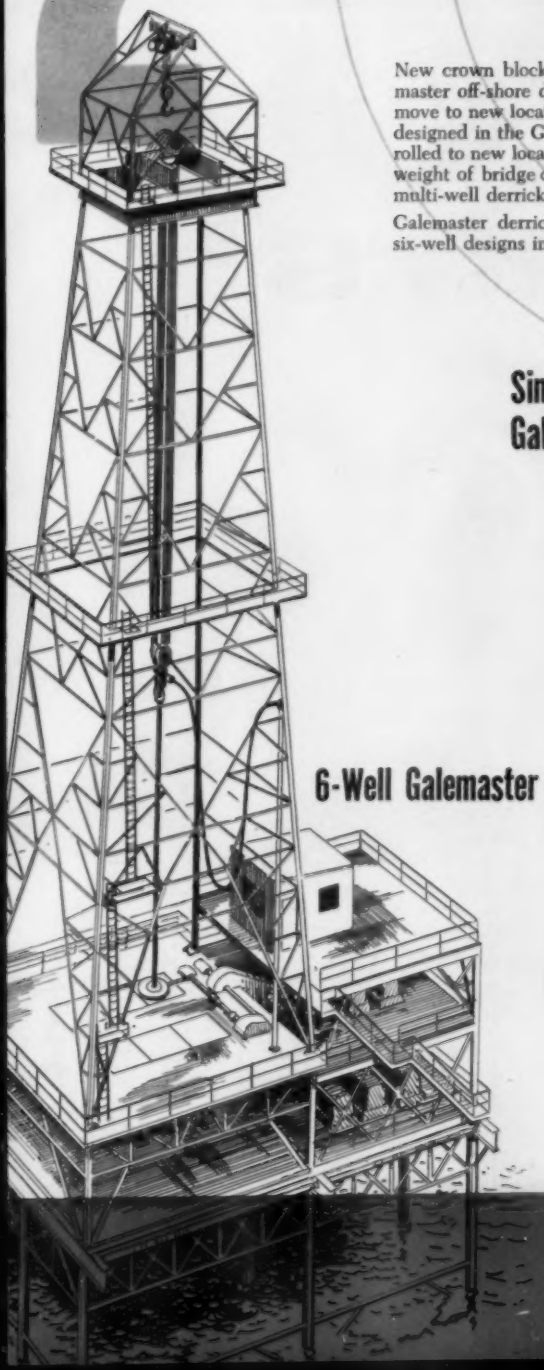
PARKERSBURG – a sign of Leadership for 60 years!

You Drill More Hole Faster with a PARKERSBURG GALEMASTER Off-Shore 6-Well Derrick...

Another Parkersburg 60th Anniversary FIRST

New crown block arrangement in the Parkersburg Galemaster off-shore derrick eliminates lifting crown block to move to new location in line of holes. With special rollers designed in the Galemaster, crown block assembly can be rolled to new location. This saves time and also eliminates weight of bridge crane and crane rails commonly in use on multi-well derricks.

Galemaster derricks are available in single, two-well or six-well designs in heights of 140 and 147 feet.



6-Well Galemaster

Single-Well Galemaster

2-Well Galemaster

Equip your next off-shore rig with a Galemaster derrick set on a Parkersburg substructure designed especially for skid-type operation. You will agree that Parkersburg substructures offer versatility and flexibility unsurpassed in off-shore drilling.

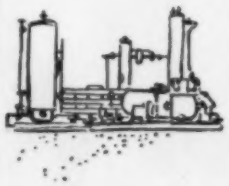
Parkersburg

60th Anniversary

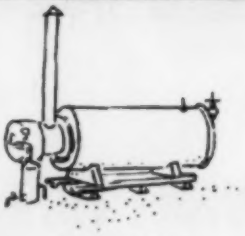
PARKERSBURG RIG and REEL COMPANY

Vertical Oil & Gas Separators

Emulsion Treaters



Hyreco Processing Units



Direct Fired Heaters

Prefabricated Steel Buildings

At Parkersburg, Quality and Service have gone hand-in-hand for

60 years!

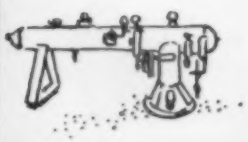
John Crawford, who founded Parkersburg Rig and Reel Company in June, 1897, was a pioneer "pig iron peddler." He walked as much as 100 miles each week to sell supplies to rig operators around Bradford, Pennsylvania. From his close contact with the men who operated the equipment came the belief on which this company is predicated – our customers deserve the best quality and service that can be obtained anywhere. We will continue to keep faith with that belief. We are not willing to rest on our laurels as a recognized leader in pioneering new and better equipment. The oil industry can continue to look to Parkersburg to point the way to better, more economical equipment.

Parkersburg

RIG AND REEL COMPANY

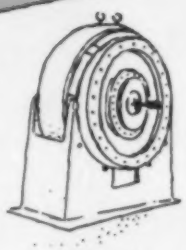
DIVISION OF PARKERSBURG-AETNA CORPORATION

3345 WINTHROP AVENUE
FORT WORTH 16, TEXAS

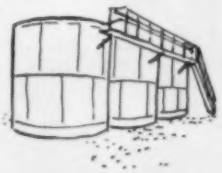


Horizontal Separators

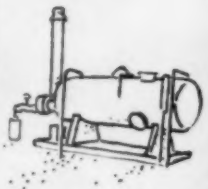
Pumping Units



Hydromatic Brakes



Lease Storage Tanks



Indirect Heaters

STOP RUST!

with

RUST-OLEUM®

and match original equipment

COLORS

Resists Salt Air, Salt Water, Sun, Heat, Fumes, Blowing Dust and Sand—Yet Dries Quickly and Hard to a High Gloss Finish!

Do the job right in the field—right over the sound rusted surface! Just scrape and wirebrush to remove rust scale and loose rust – then brush or spray Rust-Oleum 769 Damp-Proof Red Primer (or H-50 Primer) over the remaining rust. Then—follow-up with the Rust-Oleum finish coat to match the original manufacturer's colors. That's all there is to it. Applied over rust—Rust-Oleum keeps your equipment looking better . . . LONGER!

Rust-Oleum is *exclusive,* incorporating a specially-processed fish oil base that penetrates rust to bare metal. It dries right, is free of objectionable odor, is ready-mixed and self-leveling. Specify genuine Rust-Oleum. Accept no substitutes. Many leading industrial oil field supply distributors carry complete stocks for your convenience.

FOR FREE TEST SAMPLE—ATTACH TO YOUR LETTERHEAD AND MAIL TO: RUST-OLEUM CORPORATION 2478 OAKTON ST., EVANSTON, ILL.

Please Send Me a FREE TEST SAMPLE to Match the Following Color: (check sample desired)

- ☐ Test Sample of 769 Primer to be applied directly over rusted surface
- ☐ Test Sample of CATERPILLAR YELLOW
- ☐ Test Sample of NEW NATIONAL BLUE
- ☐ Test Sample of NEW UNIT RIG GRAY
- ☐ Test Sample of NEW EMSCO GREEN
- ☐ Test Sample of BETHLEHEM YELLOW
- ☐ Test Sample of WAUKESHA GRAY
- ☐ Test Sample of OIL WELL ORANGE
- ☐ Test Sample of OLD EMSCO GREEN
- ☐ Test Sample of READY-MIXED ALUMINUM
- ☐ Test Sample of HIGH GLOSS WHITE
- ☐ Test Sample of QUICK DRYING BLACK
- ☐ Nearest Source of Supply
- ☐ Complete Literature and Color Charts.

WORLD'S WORD FOR ELEVATOR QUALITY

OTIS ELEVATOR COMPANY, ALWAYS THE LEADER IN VERTICAL MATERIALS HANDLING, HAS TAKEN ITS FIRST STEP TOWARDS LEADERSHIP IN HORIZONTAL MATERIALS HANDLING.

THE BAKER-RAULANG COMPANY . . .

Among the products of The Baker-Raulang Company is the Traveloader, an entirely new concept in the field of mechanized handling of long, bulky loads. The Traveloader performs three distinct operations. It stacks like a fork truck, carries like a straddle truck, and delivers like a road truck. Gas or Diesel-powered Traveloaders are available in 6,000 to 30,000 pound capacities. A 4,000 pound capacity Electric-powered Traveloader with solid tires is available for indoor handling in narrow aisles.

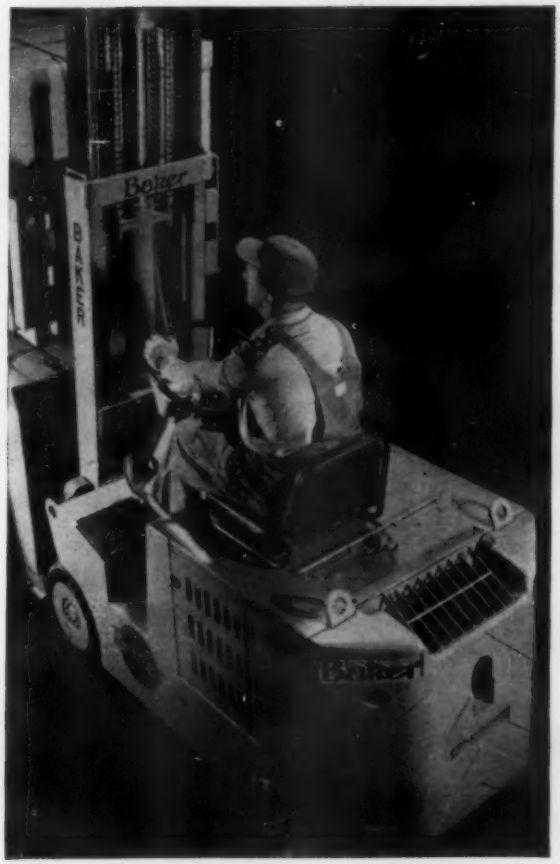
OTIS has greatly expanded the engineering and research facilities of its recently acquired subsidiary, the BAKER-RAULANG COMPANY, Cleveland, Ohio. The product line has been broadened. It now includes a complete range of GAS and ELECTRIC Fork Trucks and an exclusive line of GAS and ELECTRIC side-loading Traveloader® Trucks, also Crane and Platform Trucks. You can now look to OTIS and BAKER for progress in horizontal materials handling.

.... AN OTIS SUBSIDIARY, IS THE MAKER OF

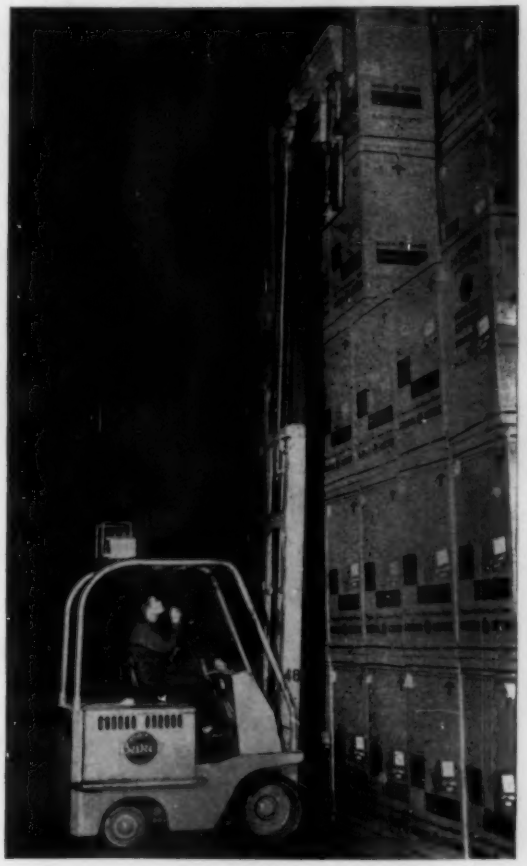
Baker®

GAS AND ELECTRIC

industrial trucks



Baker's newest gasoline powered fork truck is available in many models, with capacities to 6,000 pounds. It features low initial cost, high lift, plus speed and economies of operation.

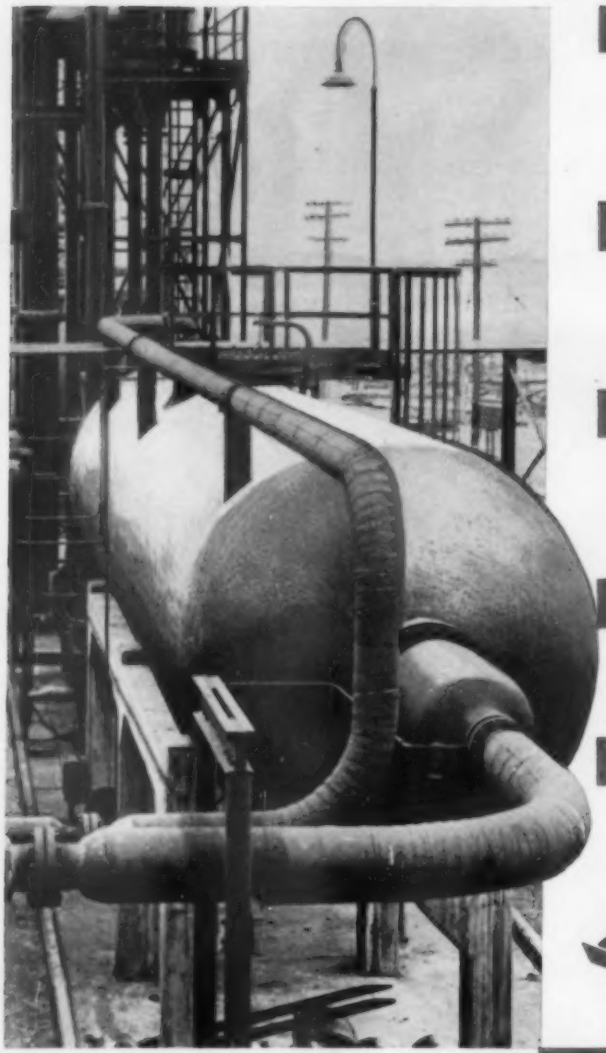


The battery-powered fork trucks in the Baker line range in capacity from 1,000 to 15,000 pounds. Baker was a pioneer in materials handling and has been producing electric industrial trucks for more than 35 years.

5 REASONS WHY

TRETOLITE all-chemical DESALTERS

are in use wherever oil is refined



1 **95 to 100% SALT REMOVAL**—The highest standards of purification possible in commercial operation. In addition to a 95 to 100% range salt removal, Tretolite Desalters also remove other solids, fines and trace metals from the crude charge.

2 **AVERAGE CHEMICAL COST OF $.0013 PER BARREL**—A real economy of operation that is consistent . . . about 1.3 mills per barrel. Water usage is also minimal, and only the pumps require power.

3 **THE ORIGINAL ALL-CHEMICAL DESALTING PROCESS**—Tretolite originated all-chemical desalting, and was the *first organization* to provide a desalting system for refiners. The result is a desalting experience unequalled in this field.

4 **PERFORMANCE-PROVED EVERY DAY BY 1½ MILLION BARRELS**—Wherever you see refining, you're sure to see Tretolite Desalters.

5 **AUTOMATIC OPERATION**—The epitome of simplicity—requires only minimum operating attention. If you have a desalting problem . . .

Ask the Man in the Red Car

The Tretolite Service Engineer is always on call to assist you in any of your maintenance and processing problems.

Chemicals and Services for the Petroleum Industry

DESALTING • DEMULSIFYING • CORROSION INHIBITING
SCALE PREVENTING • FUEL OIL ADDITIVES • WATER
DE-OILING • METAL DEACTIVATORS

TRETOLITE COMPANY

A DIVISION OF PETROLITE CORPORATION

369 Marshall Avenue, St. Louis 19, Mo.

5515 Telegraph Road, Los Angeles 22, Calif.

TD-57-2

It will pay you to get better acquainted with the

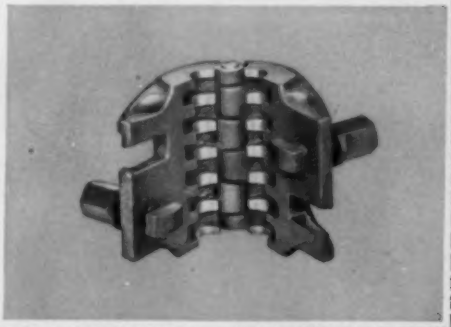
CONTINENTAL-EMSCO D+B PUMPING FAMILY

BORN, BRED AND ENGINEERED TO WORK TOGETHER

From Top-to-Bottom in any Oil Well, You'll Never Meet a More Harmonious Family—All Working with One Idea in Mind, to produce more oil for you at less cost.

CONTINENTAL-EMSCO PUMPING UNITS

D+B KWIK-GRIP® ROD CLAMPS



D+B POLISHED RODS

D+B STUFFING BOXES

D+B SUCKER RODS

D+B SUBSURFACE PUMPS

You will find that it pays to buy the complete Continental-Emsco D+B Pumping Package. See your Continental-Emsco Store today.

CONTINENTAL-EMSCO

Serving the Oil and Gas Industries ... Worldwide

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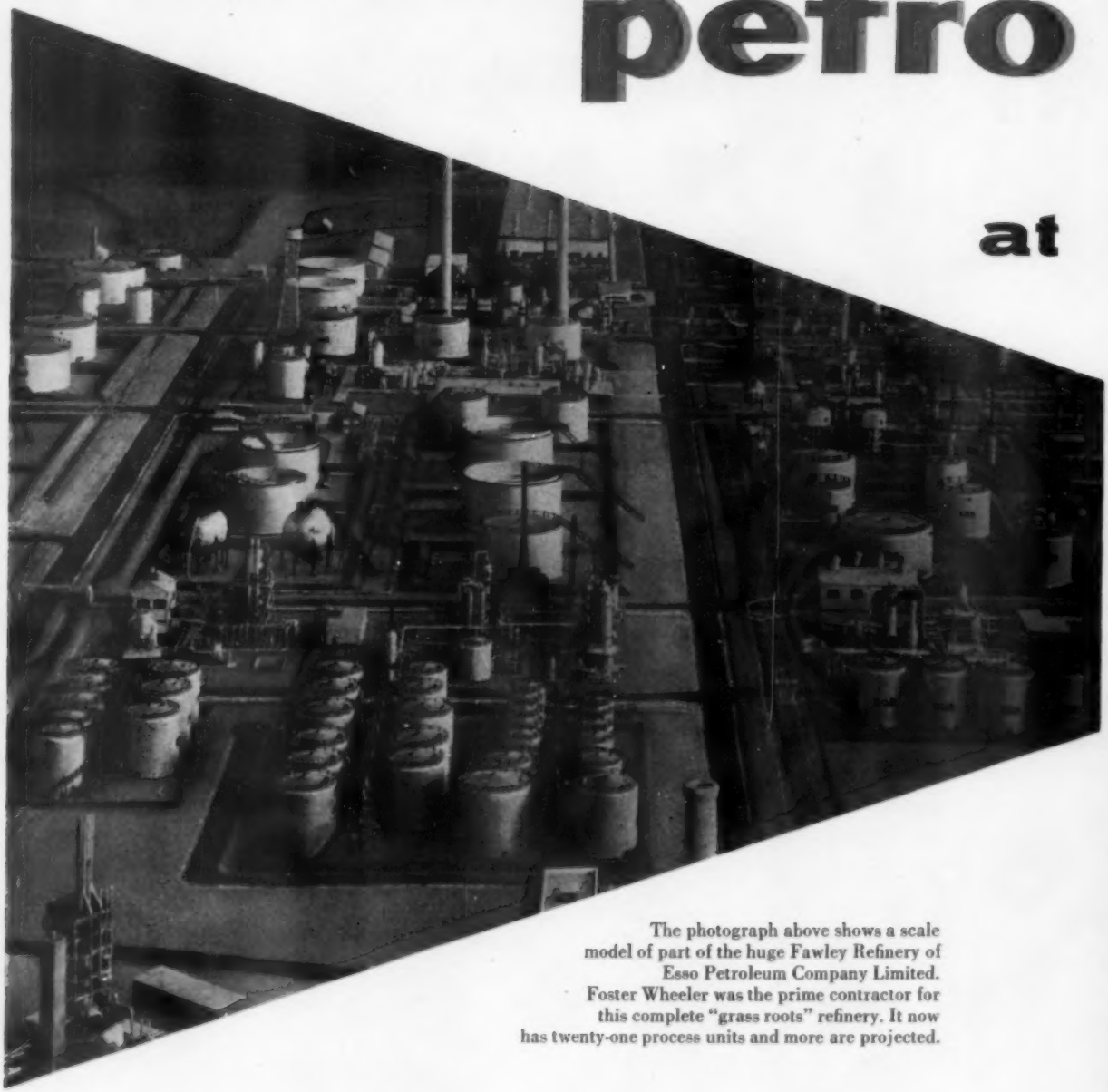


The photograph above shows a scale model of part of the huge Fawley Refinery of Esso Petroleum Company Limited. Foster Wheeler was the prime contractor for this complete "grass roots" refinery. It now has twenty-one process units and more are projected.

• FOSTER WHEELER DESIGNS AND BUILDS

PETROLEUM, CHEMICAL AND PETROCHEMICAL PROCESSING PLANTS

ANYWHERE IN THE WORLD

FW FOSTER

NEW YORK • LONDON

chemicals

FAWLEY

NEW PETROCHEMICAL PLANT for England's Largest Refinery, will be designed and built by Foster Wheeler

SYNTHETIC rubber and plastic hydrocarbon raw materials (ethylene, propylene, butylene and butadiene) will be produced from 250,000 tons per year of petroleum intermediates in a major process installation at the Fawley, England, refinery of Esso Petroleum Company Limited. Foster Wheeler, who built the new Fawley petroleum refinery, the largest in England, will also provide mechanical design and construction for this petrochemical project. Esso Research and Engineering Company supplied basic process design data.

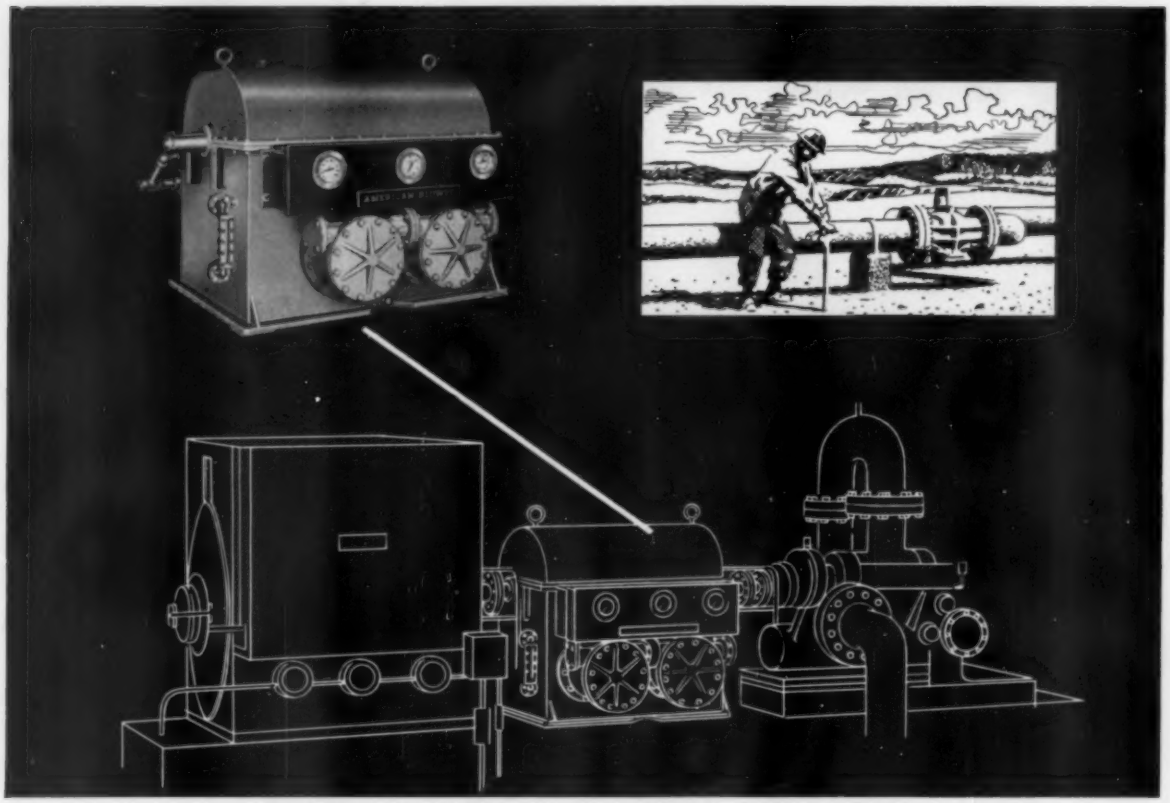
These basic hydrocarbon products represent a new and very substantial source of raw material for the British synthetic rubber and plastic industries.

Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.

WHEELER

PARIS • ST. CATHARINES, ONT.

AMERICAN BLOWER *Gyrol*® FLUID DRIVE...



Class 6 Type VS Gyrol Fluid Drive, 250 hp to 12,000 hp, speeds to 3,600 rpm.

How to get more through-put per kw consumed at pipeline pumping stations

You save power dollars in pipeline pumping stations with American Blower Gyrol Fluid Drives. Used with standard, single-speed induction motors, the stepless, adjustable-speed Gyrol units control pump flow and pressure to give the desired output at the lowest power consumption.

For many years, the dependable Gyrol Fluid Drive has satisfied the automation requirements of the power plant industry for driving centrifugal boiler-feed pumps and fans. Now, the same reliable Gyrol Fluid Drive is providing the ideal means of remote-controlled power transmission for the centrifugal pumps in unattended pipeline pumping stations.

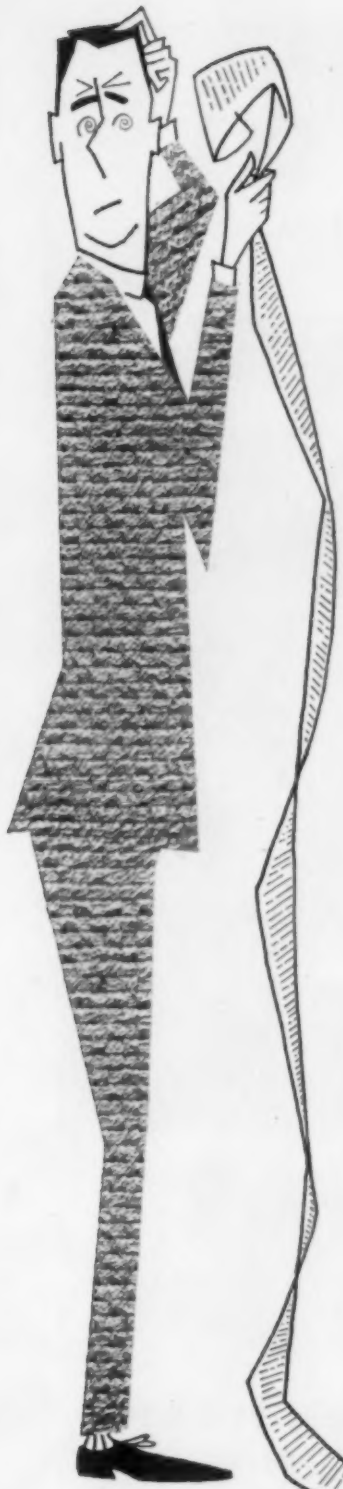
Whether you're pumping a single product or multiple products of various densities, here's how you benefit with the Gyrol Fluid Drive:

- Lower demand charges
- Power savings by adjustable pump speed
- No-load motor starting
- Wide range of pump control, permitting complete flexibility whether one or several products are being pumped
- The use of standard induction motors and Gyrol Fluid Drive to provide a safe, dependable power combination

Call your American Blower branch office for full information; or write: American Blower Division of American-Standard, Detroit 32, Michigan. In Canada: Canadian Sirocco products, Windsor, Ontario.

AMERICAN BLOWER

Division of AMERICAN-Standard



You say you've got a problem, Mister?

You say you're looking for the right steel tube analysis to withstand acids, corrosives, oxidation, high pressures and high temperatures? Mister—you *have* got a problem.

But don't give up. You can get help. National Tube has been studying refinery problems of all kinds for over 60 years. We've kept case histories of these problems and their solutions on file, and from this vast, comprehensive knowledge we've developed over two dozen different steel analyses—answers to almost every refinery tubular problem in the book.

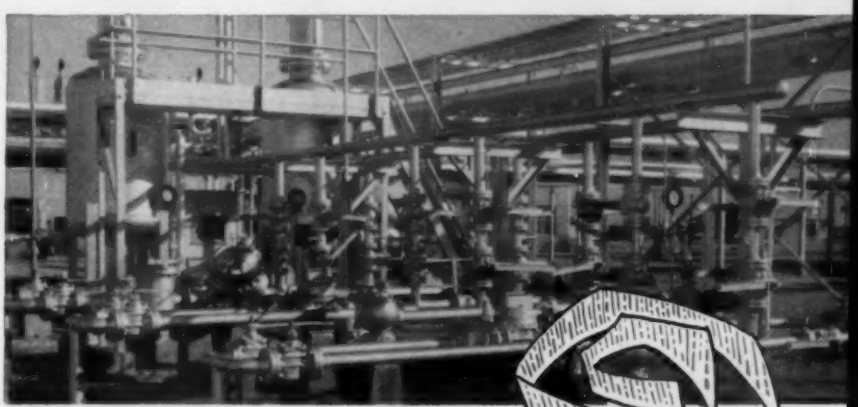
Every one of these analyses has been tested and retested in actual refinery service so that we know what can be expected of each. And, in addition to the 24 analyses shown here, other chemical compositions are available in tubular products, and a wide variety of temperature problems are under study.

So, bring your problem to us. Our expert Mill Service Force will do everything it can to help you find a solution. This force is also available for field consultation. And there is a good chance we can save you money, by finding a good alloy, at low cost, that will meet all the requirements of the job.

Write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

EXAMINE THESE TWO DOZEN DIFFERENT NATIONAL TUBE ANALYSES:

Carbon *	5 Cr, ½ Mo	17 Cr
Carbon, ½ Mo	5 Cr, ½ Mo, 1½ Si	18-8
1 Cr, ½ Mo	7 Cr, ½ Mo	18-8 Ti
1¼ Cr, ½ Mo	8 Cr, ½ Mo	18-8 Cb
2 Cr, ½ Mo	8 Cr, 1 Mo	18-8 Mo
2¼ Cr, 1 Mo	9 Cr, 1 Mo	25-20
2½ Cr, ½ Mo, ¾ Si	12 Cr	3½ Ni
3 Cr, 1 Mo	12 Cr, Al	5 Ni



NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

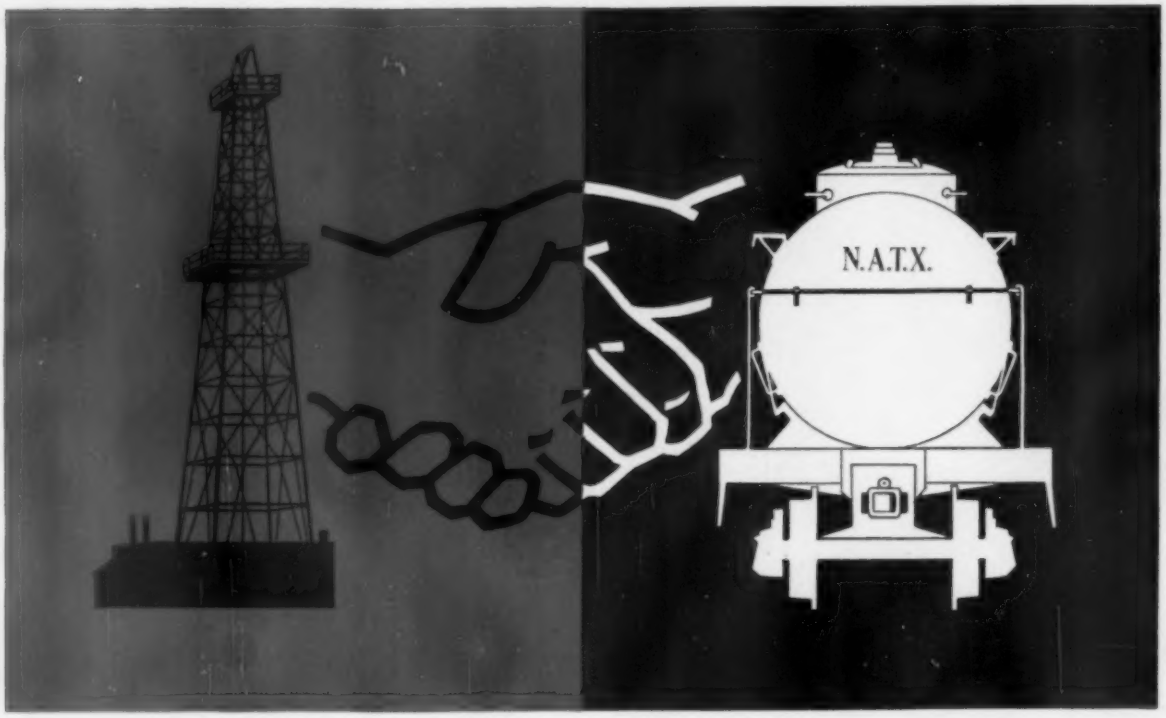
NATIONAL SEAMLESS PIPE AND TUBES

UNITED STATES STEEL

Partners for 50 *years*

NORTH AMERICAN *and the*

PETROLEUM INDUSTRY!



Among our first customers back in 1907 were shippers of petroleum products. In those days, as now, economy of bulk shipping by rail called for North American tank cars. Today the petroleum industry utilizes an increasing number of our 4,529 tank cars for safer, more dependable transportation. We are looking forward to another half century of partnership between the vital petroleum industry and progressive North American Car Corporation.

Call on us—*anytime.*

NORTH AMERICAN CAR CORPORATION

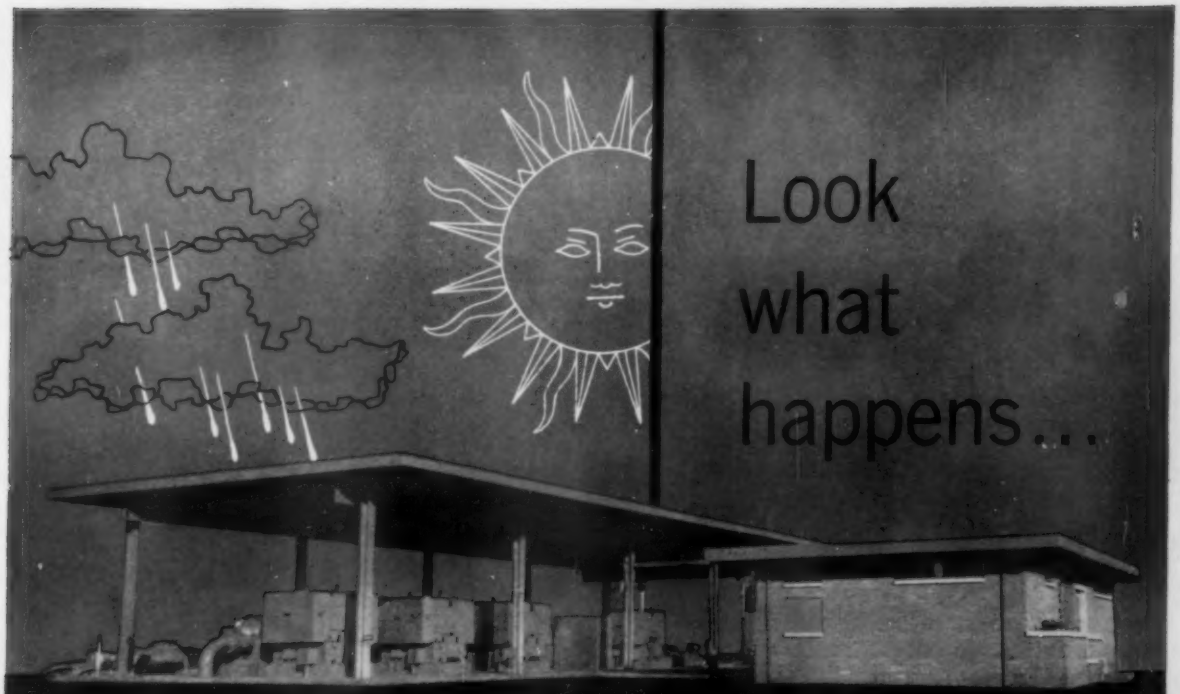
NORTH WESTERN REFRIGERATOR LINE COMPANY

MATHERS HUMANE STOCK TRANSPORTATION COMPANY

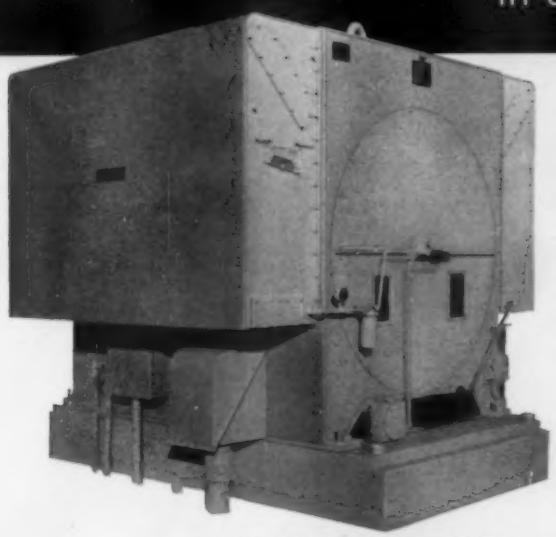
231 South La Salle Street, Chicago 4, Illinois

A NATIONWIDE ORGANIZATION WITH BRANCH OFFICES IN IMPORTANT MARKET CENTERS

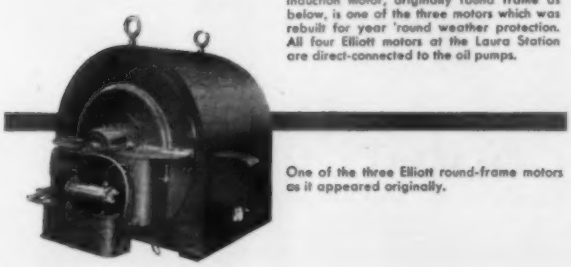
DALLAS · FOND DU LAC · ST. PAUL · ST. LOUIS · TULSA · SAN FRANCISCO · NEW YORK



when **ELLIOTT** weather-protected motors are installed in an Outdoor Pipeline Station!



This Elliott 1250-hp, 2-pole, squirrel-cage induction motor, originally round frame as below, is one of the three motors which was rebuilt for year 'round weather protection. All four Elliott motors at the Laura Station are direct-connected to the oil pumps.



One of the three Elliott round-frame motors as it appeared originally.

Costs Are Slashed. The outdoor structure costs far less and maintenance as well as year 'round operating costs are reduced. Besides that, Elliott motors are especially designed for safe, dependable, trouble-free operation *in all kinds of weather.*

Take the case of the Service Pipeline Company in Illinois. Rebuilding the above Laura Station as an outdoor facility, this company installed four Elliott weather-protected squirrel-cage induction motors. The station includes a canopy which gives extra protection from rain and sun—added insurance against the possibility of direct sunlight tripping the thermal devices, and provides a chain hoist for maintenance. Both the concrete slab area and the canopy extend far enough to provide ample working space around pumping units.

Three of the four motors, originally dripproof round-frame, were rebuilt to weather-protected designs—resulting in additional savings. Windings were given added treatment by immersing coil ends and baking. Explosion-proof bearing temperature and oil pressure relays were provided to assure maximum safety for operation in a hazardous atmosphere. These and other features of the Elliott weather-protected motors permit the erection of simplified outdoor stations instead of more costly enclosed housings. For further details, call your nearby Elliott District Office or write . . .

ELLIOTT Company

Ridgway Division • Ridgway, Pa.

87-1

UNDERWRITERS *and* FACTORY MUTUAL APPROVED

"FIRE-FLEX"

THE *Modern* FIRE HOSE

Stronger! Lighter! Longer Lengths!

COMPARE! Left: A 50 ft. coil of standard Cotton Rubber Lined, weighing 21 lbs. Right: A 100 ft. coil of "Fire-Flex", weighing only 19 lbs.

The greatest advance in fire hose construction in over half a century . . . demonstrating an entirely new concept of fire hose weight, strength and flexibility, made possible by the use of new materials and methods of manufacture.

JACKET—A combination of high-tensile fibres of outstanding strength, woven by a special process, assuring highest resistance to pressure, wear, weather and rough handling. Size-for-size, "Fire-Flex" pressure-resistance is equal or superior to the heavier and stiffer conventional cotton jackets, despite its much lighter weight. The tightly woven fabric is virtually snagproof, and is treated to resist mildew.

LINING—A light-weight yet long-wearing reinforced rubber lining, bonded firmly to the surrounding jacket, and having a perfectly smooth waterway to insure a full, fast flow. In combination, the "Fire-Flex" jacket and lining provide a fire hose far ahead of conventional types in strength, flexibility, durability, ease of handling, and economy.

Available in Several Variations to Meet All Fire-Fighting Needs

"EZ flex". The finest hose ever devised for municipal and industrial plant fire protection. Basic "Fire-Flex" construction—amazingly light and flexible, with more than sufficient strength to withstand the highest pressures involved in this broad field of fire-fighting service. Single and Double Jacket. Sizes 1½" to 3". Max. lengths of 100 feet. **Underwriters and Factory Mutual approved.**

"LITE-FLEX". A new hose with all the outstanding characteristics of "Fire-Flex" construction, described at left, *plus* a gray latex-coated cover to meet the requirements of Oil Refineries, Chemical Plants and other installations where oils, chemicals, greases and other deteriorating agents are present. Less than half the weight of regular neoprene covered hose, it has a much higher burst pressure rating, and its flexibility far surpasses any other conventional fire hose.

The very thin, lightweight jacket combines high-tensile fibres by a special weaving process that provides exceptional strength, with highest resistance to pressure, wear and rough handling.

The latex cover assures long-lasting protection from chemicals, oils, greases and moisture penetration.

"Lite-Flex" is fully rubber lined . . . seamless, multiple-ply laminated, reinforced construction, with a smooth waterway to insure unrestricted flow. Single Jacket, Sizes 1½" to 2½", in maximum lengths of 100 feet.

"SYN-FLEX". The same stronger, lighter, more flexible "Fire-Flex" construction as above, but with black "Synplastic"* instead of latex cover, for service requiring exceptionally high resistance to abrasion and/or chemicals. Single Jacket, Sizes 1½" to 2½".

"DRI-RACK". Used in place of Unlined Linen Hose for indoor protection wherever fire hose must be ready for reliable use after long periods of storage. Exceptionally light in weight and extremely flexible . . . folds into smaller space. No "weeping" while jacket is reaching maximum absorption, as with linen hose—*all the water goes on the fire!* The seamless, laminated, reinforced rubber lining is tough and durable, and will stay "alive" for years. SINGLE JACKET, Sizes 1½" and 2½". Max. lengths, 100 feet. **Factory Mutual Approved.**

Goodall Rubber Company Date_____
447 Whitehead Rd., Trenton 4, N.J.
Send complete information on the following "Fire-Flex" hose:
☐ "EZ flex" ☐ "SYN-FLEX"
☐ "LITE-FLEX" ☐ "DRI-RACK"
☐ Send representative with samples

Company _____

Address _____

City_____ Zone _____ State _____

Standard of Quality—Since 1870

HOSE • BELTING • FOOTWEAR • CLOTHING AND OTHER INDUSTRIAL RUBBER PRODUCTS

GOODALL *Rubber Company*

GENERAL OFFICES, MILLS and EXPORT DIVISION, TRENTON, N. J.
Branches and Distributors Throughout the United States and in Canada

"We use American Tiger Brand Wire Rope in all our rigs—it gives the best service."

C. B. Leatherwood
Leatherwood Drilling Co.
Jacksboro, Texas

THE Leatherwood Drilling Company has been using Tiger Brand Wire Rope for more than three years on all their rigs. Before this, they tried a number of different ropes but found that Tiger Brand gave the best service.

Rig No. 1, shown here, is equipped with 1750 feet of 1⅛" Tiger Brand with independent wire rope core. They cut back 36½ feet after every 700 ton-miles and find that this practice gives long service life.

Leatherwood Drilling Company keeps accurate ton-mile records which they consider to be the best method for judging wire rope life. That's why they use American Tiger Brand on all their rigs. It means lower wire rope costs and less rig time wasted in changing ropes.

DRILLING A WILDCAT WELL near Jacksboro, Texas with 1750 feet of Tiger Brand Wire Rope.

C. B. LEATHERWOOD, PRESIDENT (right), and Johnny Houston, Driller on Leatherwood Rig No. 1. Wire rope is kept well-lubricated.

AMERICAN STEEL & WIRE DIVISION
United States Steel, General Offices: Cleveland, Ohio
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO · TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS AMERICAN TIGER BRAND WIRE ROPE

Excellay Preformed

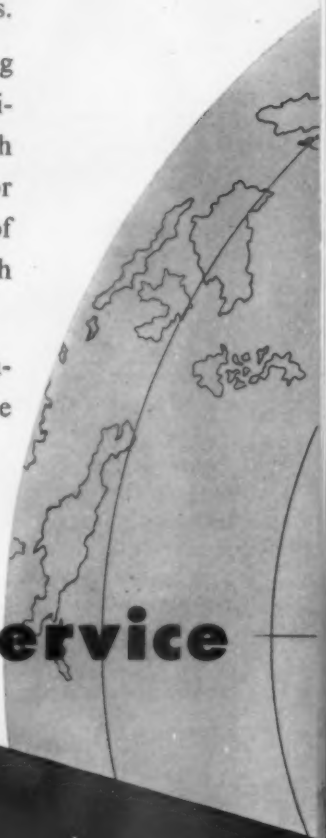
USS

UNITED STATES STEEL

Refining and research go together. The laboratory is vital to the successful operation of any oil refinery. That's why refiners, everywhere, have come to depend on UOP for many essential laboratory functions.

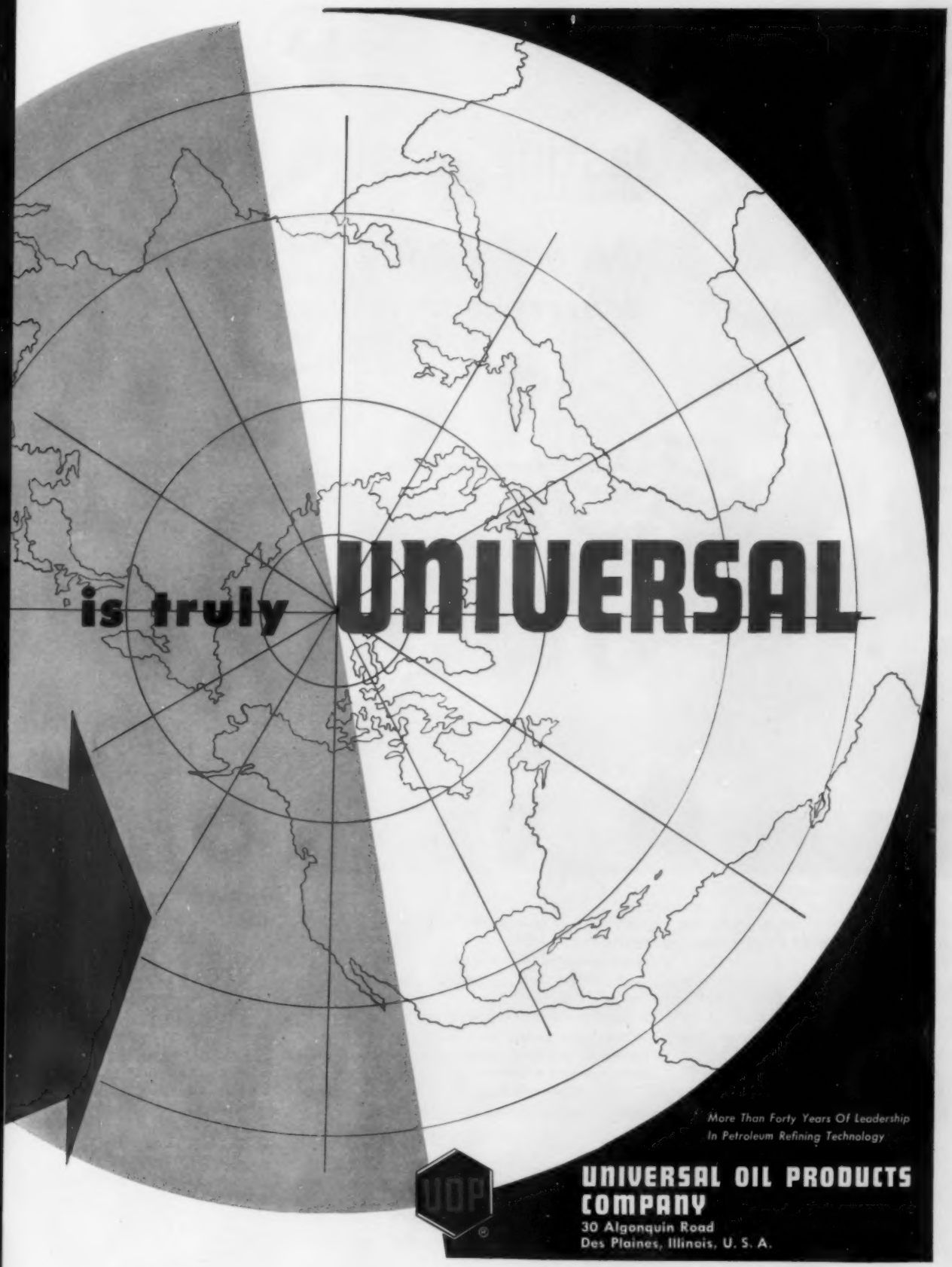
UOP laboratory service is broad, comprehensive, expert, providing vital information that in most cases would be impractical or economically impossible for the individual refiner to develop. It covers such specifics as the evaluation of crudes, problems of treating products for maximum stability, maintenance of product quality, performance of gas concentration equipment, answers all the requirements of a thorough and complete laboratory service.

Today, refiners everywhere in the free world are users of this laboratory service. It is available to any refiner, regardless of his volume or scope of operation. UOP laboratory service is truly universal.



UOP **laboratory service**

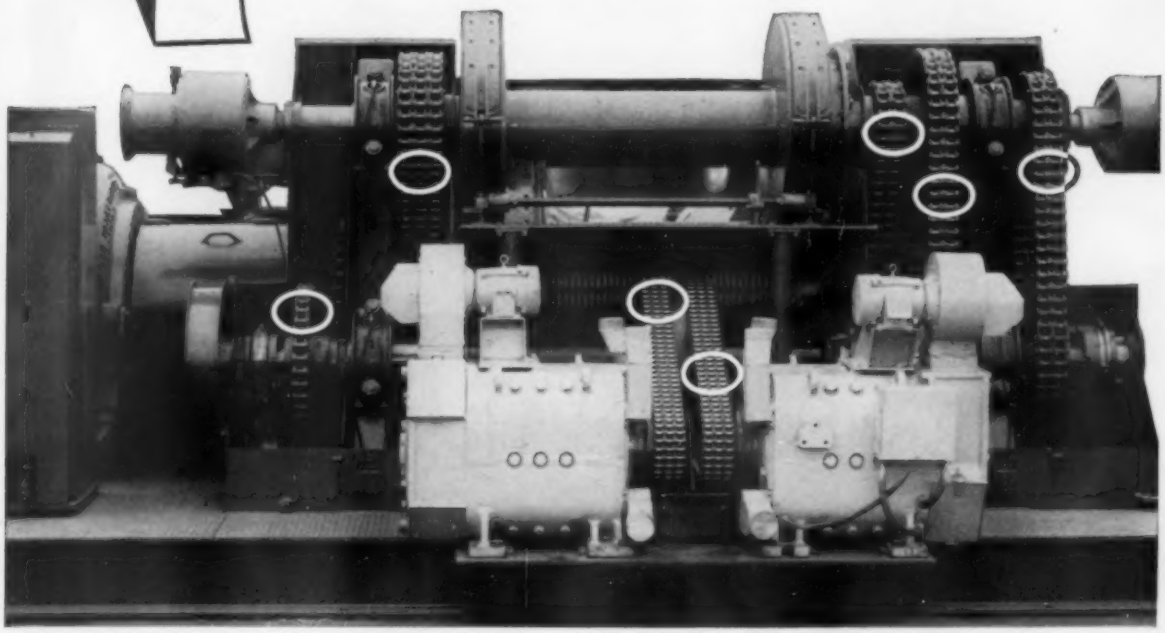
UOP Laboratories have available the most modern scientific research equipment. For example, here is one of two mass spectrometers, both of which are used for checking compositions of gas and liquids for laboratory customers. In actual operation the gas molecule is bombarded by electrons under carefully controlled conditions. Resulting fragments are sorted out by electric and magnetic fields, and recorded, thus revealing a pattern characteristic of each gas.


is truly UNIVERSAL
More Than Forty Years Of Leadership
In Petroleum Refining Technology
UOP
UNIVERSAL OIL PRODUCTS COMPANY
30 Algonquin Road
Des Plaines, Illinois, U. S. A.

REX®

7 lasting reasons why

this new EMSCO drawworks delivers longer service life



Every chain drive—seven in all—in this new Emsco EDES Drawworks is Rex Roller Chain.

Why Rex? Continental-Emsco Company knew from experience that *this* oil field chain would back up the extra speed and profits designed into this new drilling rig.

Greatly extended chain life does it. A revolutionary system of precision pitch control with fine degree tolerances assures *equal* load distribution over *all* parts. This way no one side plate is singled out for the load brunt ...no chance for costly early chain breakdown.

Here's another Rex reason: top-strength pin holes. A special manufacturing process imparts tremendous strength at these vital points.

What about disassembly? These rugged roller chains have "glide-fit" design...taking apart and recoupling are amazingly fast and simple. More money saved!

Whatever rigs you're working with, you can get more work out of your chains by specifying Rex Roller Chains. Talk to your supply store or to your Rex Field Sales Engineer. For literature, write CHAIN Belt Company, 4619 West Greenfield Avenue, Milwaukee 1, Wisconsin.

CHAIN BELT COMPANY

MILWAUKEE 1, WISCONSIN

Oil field offices: Dallas • Houston • Los Angeles • New York

NOW!

J&L Buttress-Thread Casing

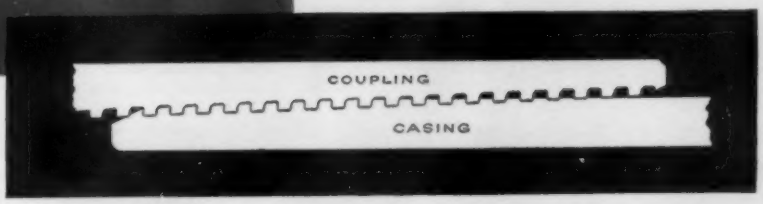
has high strength joint for toughest deep well drilling

High joint strength of J&L Buttress-Thread casing is attained by combined effect of completely engaged runout threads and the three-degree flank angle of the thread. Joint strength is almost equal to that of the body of the pipe.

Easy stabbing, rapid spinning and fewer power strokes to pull the coupling up to the power-tight position are provided by the unique thread design.

A superior casing is assured through use of quality steel, automatically controlled heat treatment, and new precision methods of machining, inspection and testing. Buttress-Thread casing is available in A. P. I. grades J-55, N-80 and P-110 as well as in still higher grades to meet special requirements.

Order this new J&L casing for use in your most severe and variable drilling operations. Write for complete information to the Jones & Laughlin Steel Corporation, Dept. 416, 3 Gateway Center, Pittsburgh 30, Pennsylvania.



Coupling threads (five per inch) engage casing threads throughout the entire length of a long coupling. The ¾ inch taper per foot is continuous and without the conventional fast angle vanishing threads. Full section of the casing is utilized in supporting weight of the string. Inside clearance of joint is not reduced by inside upsets.

J&L STEEL

Jones & Laughlin

. . . a great name in steel

BENDIX OFFERS A COMPLETELY MODERN INDUSTRIAL ENGINE MAGNETO

UNMATCHED DESIGN FEATURES

Metal Encased

Fully Ball Bearing Equipped

Pivotless Aircraft Type Breaker

Impulse Coupling Provides for Complete Adjustment of Lag Angle and Lug Position

High Output at all Operating Speeds

Metal High Tension Outlet Plate and Feed-through Condenser on Shielded Magnetos

The reputation of Bendix* in the field of ignition is truly unmatched. From the history-making flight of Lindbergh to today's fastest jets, the aviation industry has always looked to Bendix for the latest and most efficient ignition equipment. Likewise in industrial ignition Bendix has set new standards of performance in applications ranging from small outboard motors to the largest industrial engines.

That's why the introduction of this new Bendix S-400 series of magnetos is of such great importance. Here is a magneto that incorporates all of the improvements and refinements of modern ignition design.

Built to aircraft precision standards the new S-400 series is especially rugged so as to deliver trouble-free operation during long periods of service.

It is available in both four- and six-cylinder flange-mounted models in weatherproof, unshielded and radio-shielded versions.

For the important jobs where continuous top performance is a must, the new Bendix S-400 series magneto is the logical choice. Why not write today for complete details and specifications of this modern industrial engine magneto.

SCINTILLA DIVISION OF BENDIX AVIATION CORPORATION, SIDNEY, N. Y.
Export Sales and Service: Bendix International Division, 205 East 42nd St., New York 17, N. Y.

*TRADEMARK

Scintilla Division
SIDNEY, N. Y.

Bendix
AVIATION CORPORATION

There is one type of

HEAT TRANSFER SURFACE

best suited to your next heat exchanger.

G-R can impartially and authoritatively tell you which

In some cases, *bare tubes* may be the most practical type of heat transfer surface for your needs. In other cases, *finned tubes* may provide a more efficient and compact exchanger.

G-R builds heat transfer apparatus with *either* bare tubes or finned tubes. G-R finned tube surfaces include both longitudinal G-Fin and helical K-Fin . . . two widely popular types that have proved their superiority in hundreds of thousands of installations throughout the world.

G-R builds both shell-and-tube units and open sections . . . for large or small capacities . . . for high or low temperatures and pressures . . . for clean or clogging fluids, with high or low heat transfer rates. Your problem involves some of these conditions. G-R engineers have met all these conditions in all of their combinations. Let us advise you. Call in a G-R representative today.

THE GRISCOM-RUSSELL CO.

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

MASSILLON, OHIO

HERE'S AN EXAMPLE OF G-R LEADERSHIP IN HEAT TRANSFER APPARATUS

Name your test for heat exchangers

and apply it to

G-R Twin G-Fin Sections

Is it the DESIGN test?

G-R Twin G-Fin Sections are the simplest form of heat exchanger—a pipe within a pipe, with head end closure consisting of only 4 parts.

Is it the ADAPTABILITY test?

More than 80,000 G-R Twin G-Fin Sections are in use on a wider range of heat transfer services than any other design of heat exchanger on the market.

Is it the BACKGROUND test?

G-R Twin G-Fin Sections have been on the market for 25 years, and their design and construction are based on 90 years of experience in building heat transfer apparatus.

Is it the PERFORMANCE test?

Many thousands of G-R Twin G-Fin Sections have been in service for 10 years and longer with negligible maintenance cost and without replacements of any kind.

Is it the EFFECTIVENESS test?

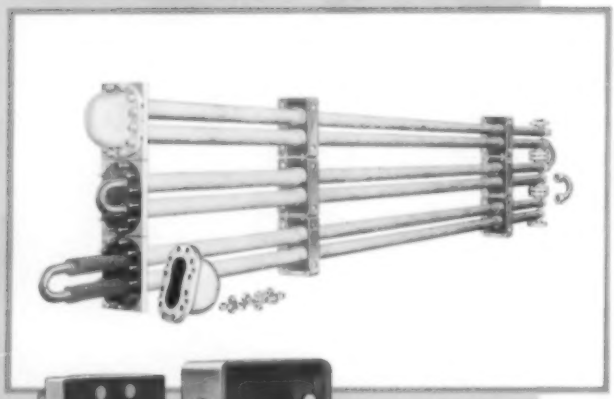
The G-R Twin G-Fin Section has elements with longitudinal G-Fins that have 6 to 8 times the external transfer surface of bare tubes, thereby permitting fewer tubes to handle services in which the two fluids have unequal heat conductivity.

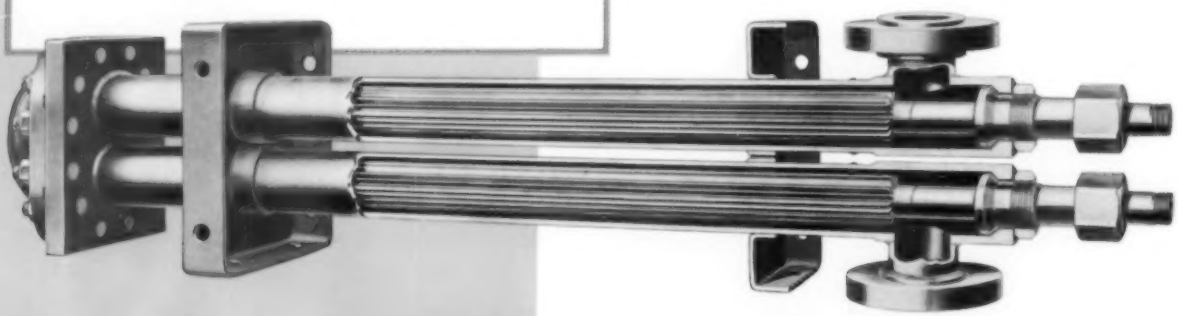
Is it the RATING test?

The long and extensive experience of the G-R engineers in heat transfer, and the operating results of the many tens of thousands of G-R Twin G-Fin Sections in service assure ratings which are authoritative and dependable and can be guaranteed.

Is it the CONVENIENCE test?

G-R Twin G-Fin Sections are standard and interchangeable. They are easily handled, can be shifted from one kind of heat transfer service to another, can be installed in series or parallel to suit the desired capacity and temperature range, and sections can be added or removed to meet changes in operating conditions.





Write for bulletin describing these "universal" heat exchangers in detail.

THE GRISCOM-RUSSELL CO.

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

MASSILLON, OHIO

GR370

By Glenn Taliaferro
Johnston Testers

FOR MORE INFORMATION AT THE BOTTOM OF YOUR WELL

FIVE Important Points of D. S. T. Pressure Charts

The science of reservoir engineering is putting greater demand on the field engineer for understanding and interpretative knowledge of Drill Stem Test Pressure Charts. Technical reservoir information can be enhanced by utilizing drill stem test data.

Realizing there is a need for proper evaluation of such data, Johnston Testers is complying by furnishing to the industry a pressure chart combining both "expanded" time and "expanded" pressure. Figures A and B illustrate the same chart, Figure A having the advantage of "expanded" time and "expanded" pressure to aid in the interpretation. By placing Figure A on a *reduced time* scale and removing the *extra inches* of deflection Figure B is produced.

Although Figure A presents a rather complicated appearance, it is simplified by realizing that

1. The chart progresses from right to left and that
2. When a pressure line reaches the left extremity of the chart it will reappear AT THE SAME PRESSURE READING ON THE RIGHT SIDE.

Points of interest on Figure A

1. Initial hydrostatic mud pressure.
2. Initial flowing pressure.
3. Final flowing pressure.
4. Final shut-in pressure.
5. Final hydrostatic mud pressure.

Reading from right to left, the pressure chart indicates the build-up hydrostatic pressure as the testing assembly is lowered in the hole. Upon reaching bottom the initial hydrostatic head of the mud column is recorded in pounds per square inch as indicated at point "1".

With the testing assembly on bottom, weight is applied and the packer is expanded isolating the desired test zone.

After the packer expands, the test tool opens exposing the test zone to the conditions in the drill pipe. This allows the pressure to drop from the initial hydrostatic mud pressure at point "1" to the initial flowing pressure at point "2" and with this decrease of pressure on the test interval, the fluid in the formation is permitted to flow into the well bore.

As the fluid flows from the formation through the perforated anchor and into the drill pipe, the pressure recorders accurately record the increase of pressure from the initial flow pressure at point "2" to the final flow pressure at point "3".

Any changes in pressure during the flow period will be recorded whether they are caused by tool manipulations or formation characteristics and will be easily identified on the flow curve. Examples of these pressure changes during the flowing period could be changing chokes at the surface, partial or complete plugging during the test, operating the equalizing valve to unplug the test tool.

After the well has been flowing for the desired length of time, the shut-in valve in the testing assembly is closed by rotating the pipe to the right. The small volume in the tester assembly from the shut-in valve to the bottom of the hole allows a rapid build-up toward the formation or reservoir pressure and the final shut-in pressure is recorded at point "4".

After the shut-in period is completed the equalizing ports are opened, allowing the mud to flow below the packer, facilitating easy removal of the packer from the packer seat. As the mud equalizes below the packer, the pressure increases to the final hydrostatic mud pressure at point "5" and as the tester is removed from the hole the chart shows the decrease in pressure and returns to the base line as the test tool reaches the surface.

All the pressures measured and recorded are due to the "actions" of various fluids encountered or controlled by the Tester. Mechanical operations, such as sudden changes in running speed, jarring, and so on, will record as vertical lines (pressure) very short time intervals. These lines will not confuse the actual test pressures as they are readily recognized as forces other than those caused by the formation.

For more comprehensive interpretative data write Johnston Testers for the booklet entitled "The Interpretation of Drill Stem Test Data."

FIGURE A

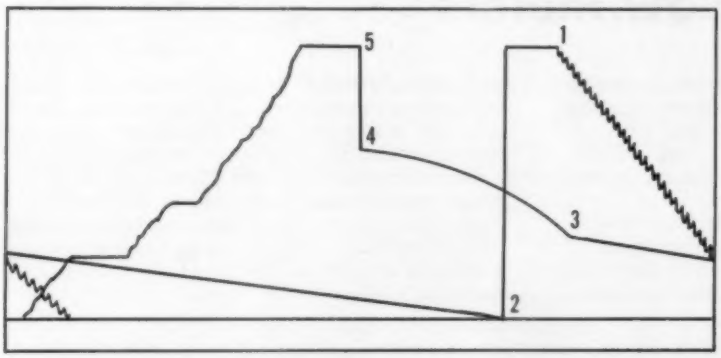
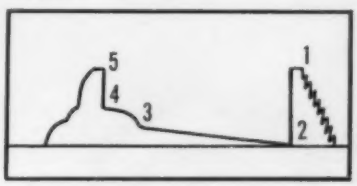


FIGURE B



GLENN TALIAFERRO
Manager of Chart Dept.
Johnston Testers
Houston, Texas

JOHNSTON TESTERS

A Subsidiary of Schlumberger Well Surveying Corporation

first in drill stem testing

HOUSTON, TEXAS

LOS ANGELES, CALIF. CALGARY, CAN.

FORMATION AND CASING TESTING
JOHNSTON

Foxboro Flow Meters get "sea-duty" measuring gas flow on platform in Gulf of Mexico. Well pressure is 1900 lbs.; pressure upsteam from chokes 800 lbs.; meter-run pressure 500 lbs.

. . . Foxboro Flow Meters

Rugged, accurate, thoroughly dependable — whether they're measuring gas flow on an off-shore platform or on a wind-swept desert! That's the field performance record of Foxboro Flow Meters . . . the reliable, economical means of charting and prorating well production.

Basic "better-design" of these Foxboro Meters *assures* accuracy with essentially *no* maintenance! For example, transmission of float motion to the pen is *linear* — through the exclusive segmental lever drive and "life-lubricated" anti-friction bearing. There's no calibration compromise . . . no lost motion. And these are only a few of many engineered advances that pay off in troublefree gas measurement.

There are Foxboro Flow Meters for all production pressures. Especially adapted to field metering, the Type 22 is popular for working pressures to 2000 psi. The heavy-duty Type 26 is widely used for working pressures to 5000 psi. For complete details, write for Bulletin 7-10A.

THE FOXBORO COMPANY, 605 NORFOLK STREET, FOXBORO, MASS. U.S.A.

FOXBORO REG. U. S. PAT. OFF. Oil and Gas FLOW METERS

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

Change motors in minutes—

with FALK *all-steel* MOTOREDUCERS

No long and costly "down time" involved

Motors can be interchanged or replaced *in minutes* with the all-steel, All-Motor type FALK Motoreducer. No long and costly "down time" is involved in making the change!

Best of all, replacement is not limited to original make of motor—new NEMA frames may be substituted for old. This versatile Motoreducer operates with any make, speed or type of standard foot-mounted motor within its AGMA rating. No modification, no special shaft, no "partial" motor required.

In addition to unmatched motor interchangeability, this dependable gear drive—the "work horse of industry"—offers: widest choice of output-shaft position (horizontal, vertical, right-angle)...any output-shaft connection...any mounting, including wall and ceiling...standard speed range from 1.5 rpm to 1430 rpm. All these advantages, plus proved efficiency, low maintenance and extra-long life, make the All-Motor type FALK Motoreducer your best buy for any job requirement.

Furnished in sizes up to 75 hp with any make, style or type of motor; or, *without a motor if desired.* FALK Motoreducers are available from convenient factory, field or distributor stocks, from coast to coast.

Write for Bulletin 3100

THE FALK CORPORATION, MILWAUKEE, WISCONSIN

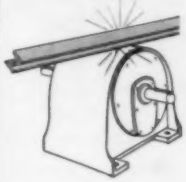
MANUFACTURERS OF:

- Motoreducers
- Speed Reducers
- Flexible Couplings
- Shaft Mounted Drives
- High Speed Drives
- Special Gear Drives
- Single Helical Gears
- Herringbone Gears
- Marine Drives
- Steel Castings
- Weldments
- Contract Machining

FALK

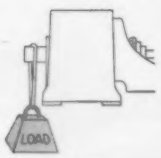
...a good name in industry

FALK "IN-BUILT" FACTORS assure full dependability—better service—longer life



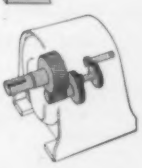
ALL-STEEL HOUSINGS

Rugged, strong, rigid ...all parts heavy steel plate, formed and welded in the Falk Weld Shop.



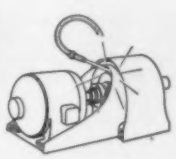
LARGE OVERHUNG LOAD CAPACITY

Large shafts, oversize bearings...rigid mountings with wide bearing spans to handle maximum loads.



PRECISION GEARING

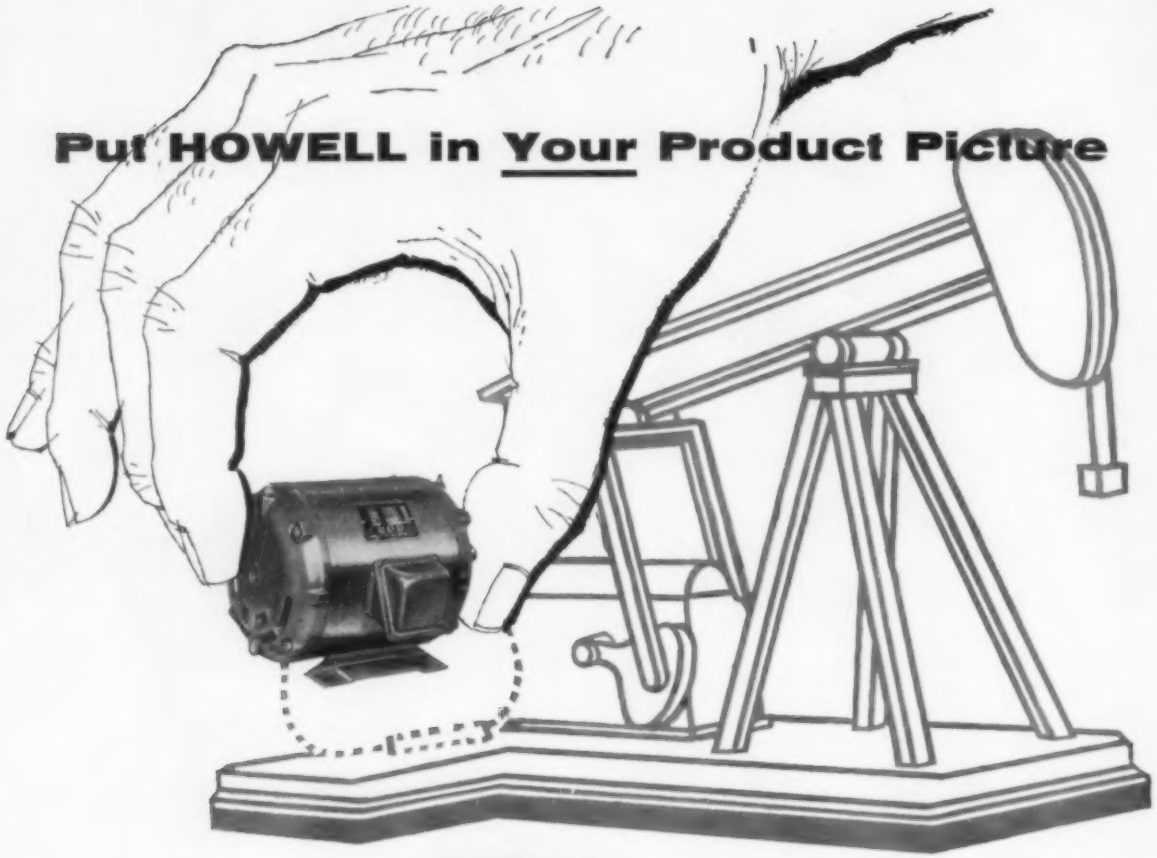
Heat-treated alloy steel gearing, precision cut and shaved after heat treatment to eliminate distortion.



SEALED HOUSINGS

Splashproof, dustproof, oiltight. Dual closures and one-way vents keep oil in, dust and moisture out.

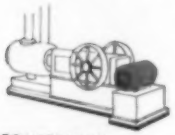
Put HOWELL in Your Product Picture



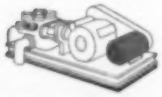
...and gain the PLUS values in power that count!

PROCESSING PUMPS

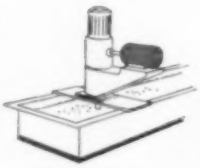
MOTORIZED VALVES



COMPRESSORS



PIPE LINE PUMPS



MUD MIXERS

When thousands of dollars worth of equipment can be idled by a single motor failure, it stands to reason you want the best motor you can get. That's the reason so many manufacturers of oil production machinery rely upon Howell motors to keep their equipment going strong . . . year after year . . . with a minimum of maintenance. Howell gives you:

EXTRA DEPENDABILITY that challenges the years. Howell's new principle of heat-source ventilation . . . double sealed bearings . . . tough rolled steel frames and precision fitted cast iron end plates . . . these and many more are plus values that *count!*

AN UNSURPASSED REPUTATION for engineering excellence and quality manufacture . . . built up by Howell in over 40 years of serving industry's AC motor requirements.

Howell weather-protected motors, in sizes up to 300 hp, are ideal for heavy-duty applications. They're rodent-proof, rust-proofed inside and out, and stream-lined — no external fins or ribs to accumulate dust and dirt. Howell also makes standard open, TEFC and explosion-proof motors, gear-motors and part winding motors for oil industry applications.

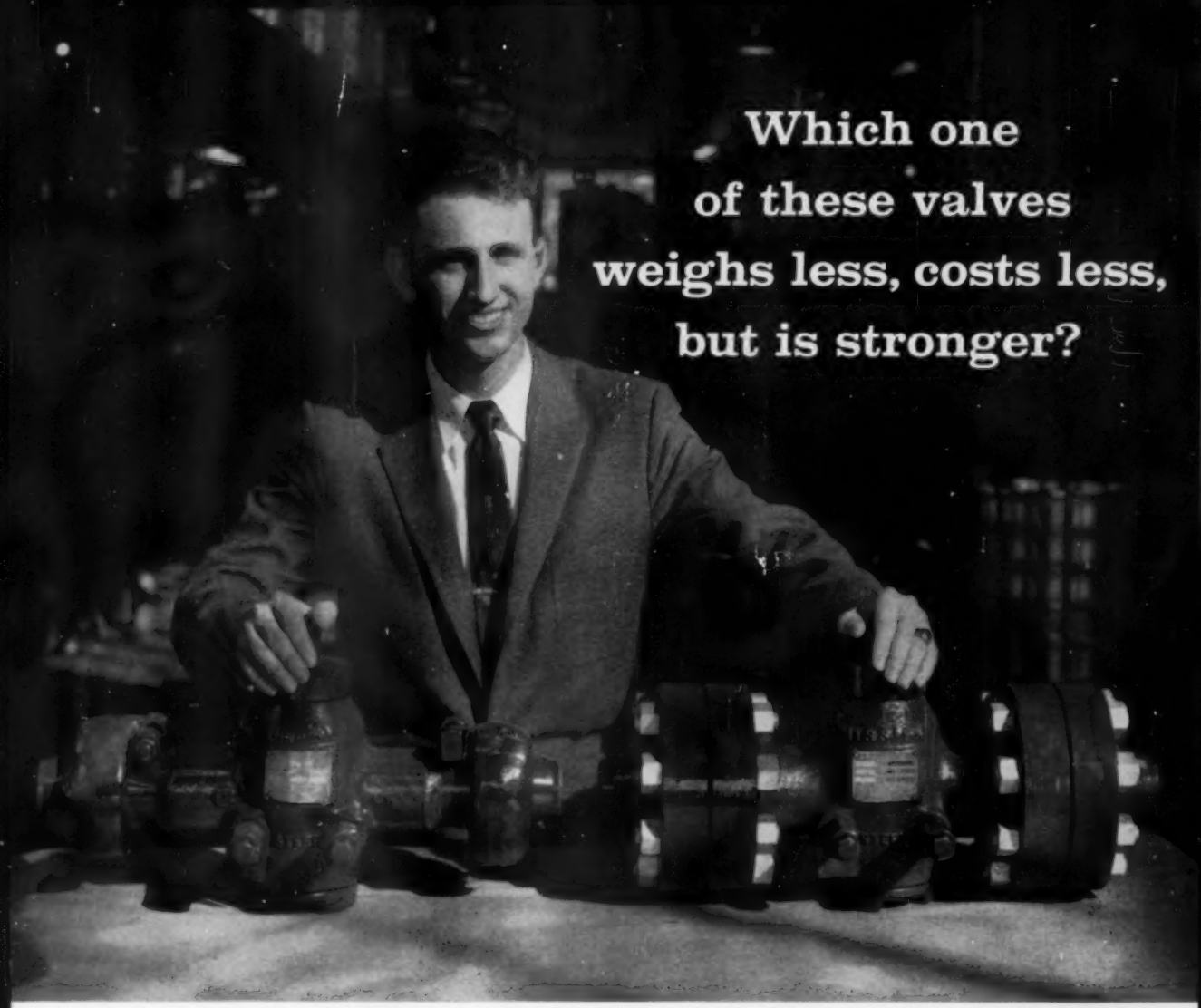
Howell motors are specified and used by these leading manufacturers of oil production equipment:

Philadelphia Gear Works, Inc. • The Worthington Corp. • Toledo Pipe Threading Co. • Aurora Pump Division, The New York Air Brake Co. • Hercules Tool Company.

A Howell sales engineer can give you valuable assistance on any motor application. Wire or 'phone collect . . . or drop us a line . . . you'll get prompt action. Howell Electric Motors Co., Howell, Michigan.

HOWELL *motors*

. . . precision built for industry since 1915



Both of these valves are of the same make, model, size, and pressure rating. One is equipped with 2″, 6000 lbs. test, Unibolt Couplings, the other with 2″, Series 900 flanges. The Unibolt-equipped valve weighs 102 lbs. less, costs about 10% less, and is approximately 28% stronger!

And the advantages don't stop there. Because it weighs less, the Unibolt-equipped valve costs less to ship and is easier to handle, easier to install. (Two bolts and nuts, compared to 16 bolts and 32 nuts.)

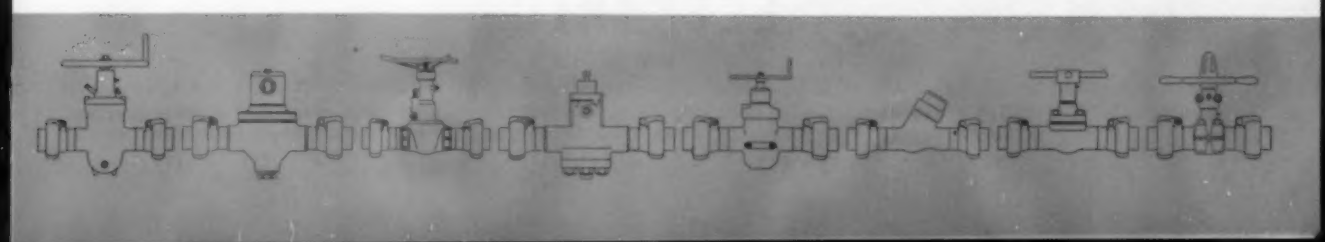
Unibolt Couplings are easy to attach to any valve. Either hub of the Coupling may be butt-welded, socket-welded or screwed to the valve body.

Even if steel were plentiful, Unibolt-equipped valves—as opposed to flanged valves—would be your best buy.

THORNHILL CRAVER CO.

P. O. Box 1184, Houston, Texas

ask your supplier to furnish unibolt-equipped valves



Why General Electric Drive Proves Best For Oil Well Drilling Rig Electrification

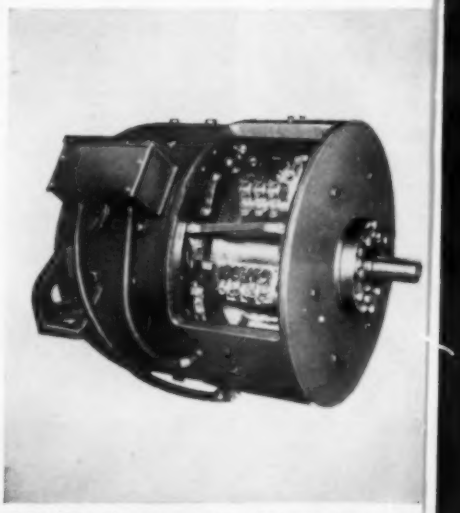
1 Control simplicity inherent in motor and generator design. General Electric's differential generators eliminate the need for complicated external current and voltage regulating controls, feed-back systems, and torque limiting devices used in some makes of electric drive. Moreover, General Electric's familiar air throttle system eliminates the individual exciters for each generator. The G-E shunt motor will not run away in case of load loss and therefore requires no speed-limiting control devices. This motor has excellent braking characteristics without any added controls. All control provided for the General Electric drive system assures complete regulation of speed and torque simply and efficiently.

2 Can be used with almost any popular oil field engine. A great number of popular oil field engines can be used with General Electric drive including spare engines which you may have in stock. The advantage here is that preference for and familiarity with a particular make of engine need not be sacrificed to gain the benefits of this reliable, efficient, low-maintenance drive system. Parts programs need not be complicated by the addition of a different line. General Electric and the engine builder co-operate so that engine-generator sets are furnished as a completely engineered package. G.E. has two generators available for oil field applications. The GT558R1 generator is a single-bearing, flange-mounted, self-ventilated machine with the following input horsepower ratings: 200 hp at 1200 rpm, 240 hp at 1400 rpm, 280 hp at 1600 rpm, 320 hp at 1800 rpm, 340 hp at 2000 rpm, 350 hp at 2100 rpm. The GE752J generator is a two bearing, single shaft, separately ventilated generator. (It is also available as a two shaft extension machine.) This generator has the following input horsepower ratings: 450 hp at 850 rpm, 550 hp at 900 rpm, 600 hp at 1000-1300 rpm. The GE752H2 motor rates 625 hp continuously and up to 1000 hp for hoisting at 950 rpm.

3 Designed and built by the original manufacturers of electric drive. General Electric is primarily an electrical equipment manufacturer with years of experience in the manufacture of electrical apparatus. The simplicity and flexibility which mark General Electric drive are the result of leadership in the electrical field. The electric drive that will mean so much to your rig operation and to your cost per foot of hole has been pioneered and developed by G.E.

For more information, call your nearest G-E Apparatus Sales Office. (Principal drilling offices in Dallas, Houston, New Orleans, Denver, Tulsa, and Los Angeles.) Locomotive and Car Equipment Department, Erie, Pa. 115-22

PRINCIPAL



GT558R1 direct current main generator with inspection covers removed.

Progress Is Our Most Important Product

GENERAL ELECTRIC

Operator at drilling controls of General Electric equipped rig built for Shell Oil Company by Ideco, one of the Dresser Industries. Standard air throttles are used for speed controls. These can be incorporated in the draw works console with other air controls, simplifying operation.

GENERAL ELECTRIC DRIVE COMPONENTS:

GE752J direct current main generator with top-mounted blower assembly.

GE752H2 direct current, 1000 hp motor with top-mounted blower assembly.

General Electric control console for use at driller's position.

INTENT CRAFTSMEN

Quality craftsmanship is amply demonstrated by Graver skills with automatic aluminum welding equal to ASME X-ray standards. Graver's advanced welding techniques are among the reasons Graver is called upon regularly to fabricate aluminum, alloys and carbon steel into a variety of shop-built and field-erected pressure vessels and storage tanks. It will pay you to inquire about how Graver craftsmanship and experience can be valuable to you, too.

ALLOY DIVISION

1857-1957 GRAVER®
A CENTURY OF CRAFTSMANSHIP IN STEELS AND ALLOYS

GRAVER TANK & MFG. CO., INC.

EAST CHICAGO, INDIANA • NEW YORK • PHILADELPHIA • EDGE MOOR, DELAWARE
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MAXIMUM STRENGTH...
Not a Wish...
A REALITY
with ACCO
AMERICAN
TRU-LAY
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15% STRONGER
Acco Tru-Lay VHS rotary drilling line is 15% stronger than improved plow steel. This means with Stronger ACCO VHS you can drill deeper before increasing the number of lines. Its toughness gives it high resistance to abrasion and greater resistance to peening ... Important in maintaining wire rope diameter and shape. Contact your Mid-Continent Supply Company representative for complete information. Mid-Continent Supply Stores, Sales Offices and Sales Representatives are located in all active oil areas.
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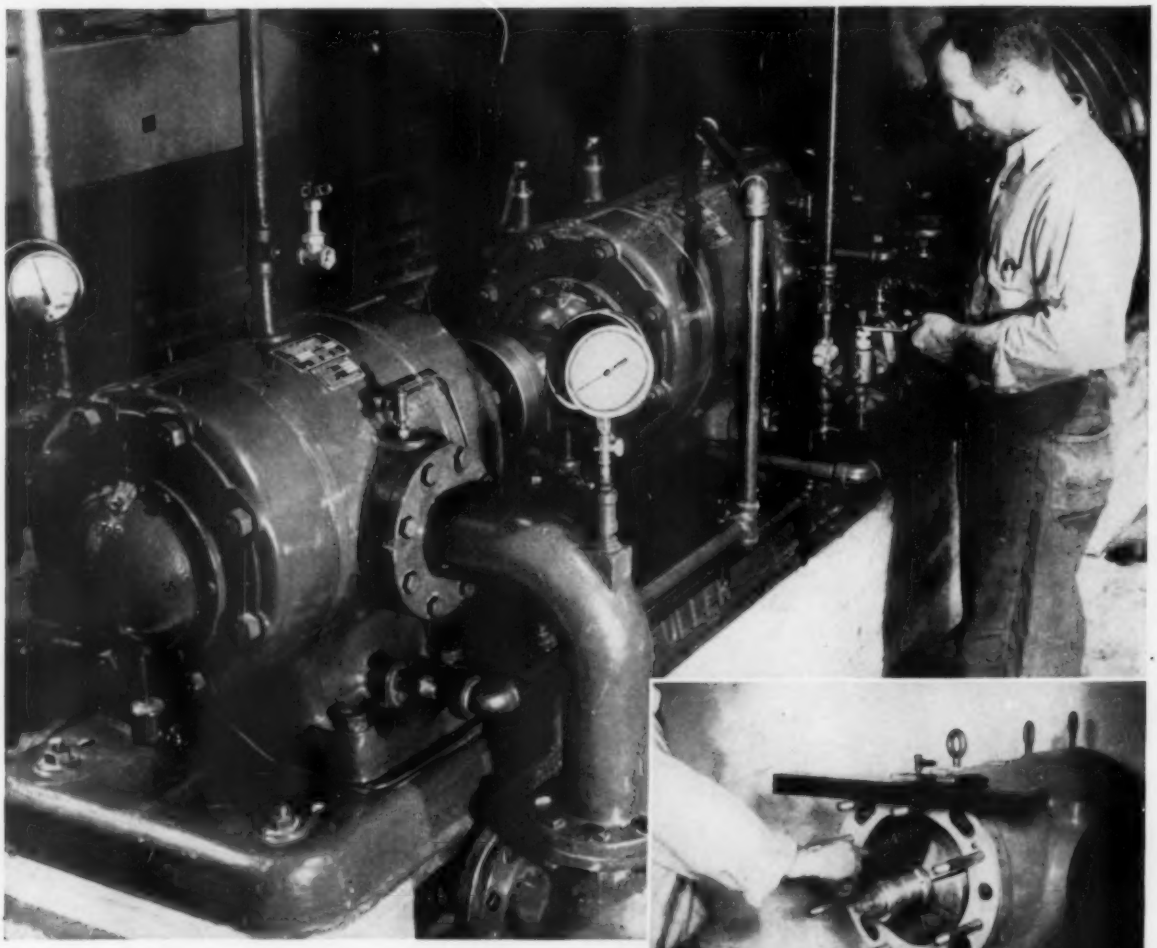
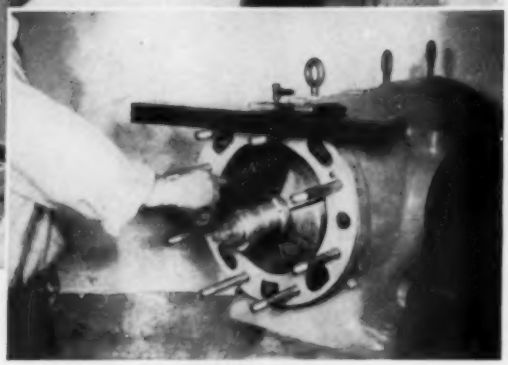
THE WORLD'S LARGEST INDEPENDENT OIL FIELD SUPPLY COMPANY





Blade inspection

PERFECT COMBINATION OF MEN AND MACHINES

Providing plant air for varied uses imposes heavy responsibility on both the compressor and its operator to keep production moving.

The simplicity of the Fuller Rotary Compressor principle reduces maintenance to an absolute minimum; by the same token, operator's universal pride in Fuller Rotary performance contributes to longer life of the compressor. Few moving parts and smooth operation limit the operator's work to periodic inspection.

This perfect combination of men and machines is worth investigating, with an eye to economies you, too, can enjoy. Write to Fuller Company, compressor sales department for detailed information.

FULLER COMPANY
132 Bridge St., Catasauqua, Pa.
SUBSIDIARY OF GENERAL AMERICAN TRANSPORTATION CORPORATION
Birmingham · Chicago · Kansas City · Los Angeles · San Francisco · Seattle

C-316
4686

PIONEERS OF HIGH-EFFICIENCY VANE TYPE ROTARY COMPRESSORS SINCE 1930

Humble's Corexit

Reduces Your Lifting Costs by Preventing Sub-surface Corrosion

Corexit treatments protect sucker rods and tubing against corrosion and hydrogen embrittlement. Batched down the annulus, *Corexit* works rapidly to clean up your sub-surface equipment, to displace corrosive brine and loose scale from the metal surfaces. Then it builds up a tenacious and durable protective film on these cleaned metal surfaces to prevent further corrosion. Following the initial treatment, the use of a small amount of *Corexit* daily will maintain this tough protective film.

Consequently, you will find lifting costs lower, because *Corexit* prolongs the life of your equipment, and reduces the number of well pulling jobs.

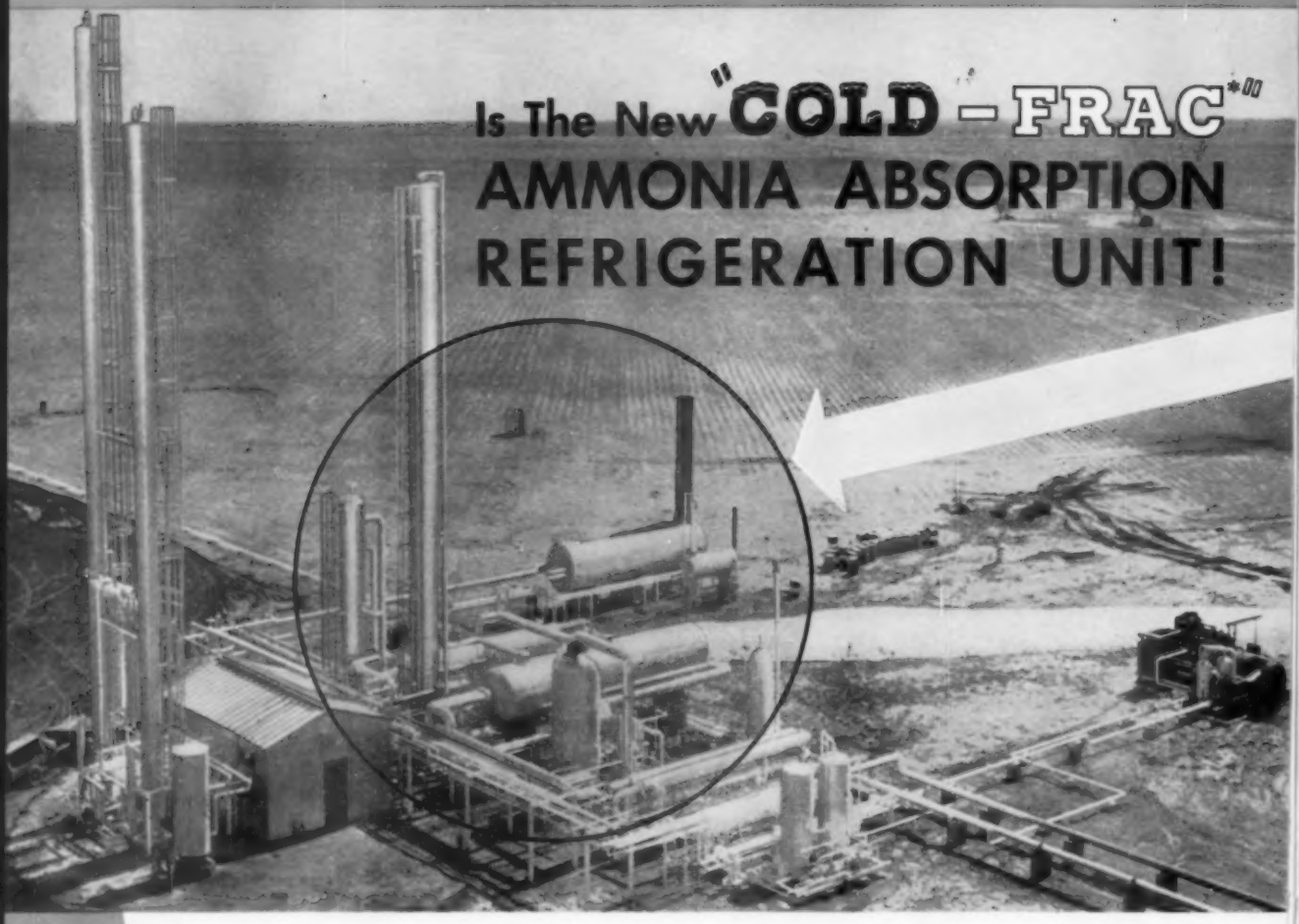
For complete information on *Corexit,* call your nearest Humble wholesale plant in Texas and New Mexico, or write or phone:

HUMBLE OIL & REFINING COMPANY

HUMBLE

Technical Service
Sales Department
Humble Oil & Refining Company
P. O. Box 2180
Houston, Texas

The "Heart" Of This BS&B



Is The New "COLD-FRAC*" AMMONIA ABSORPTION REFRIGERATION UNIT!

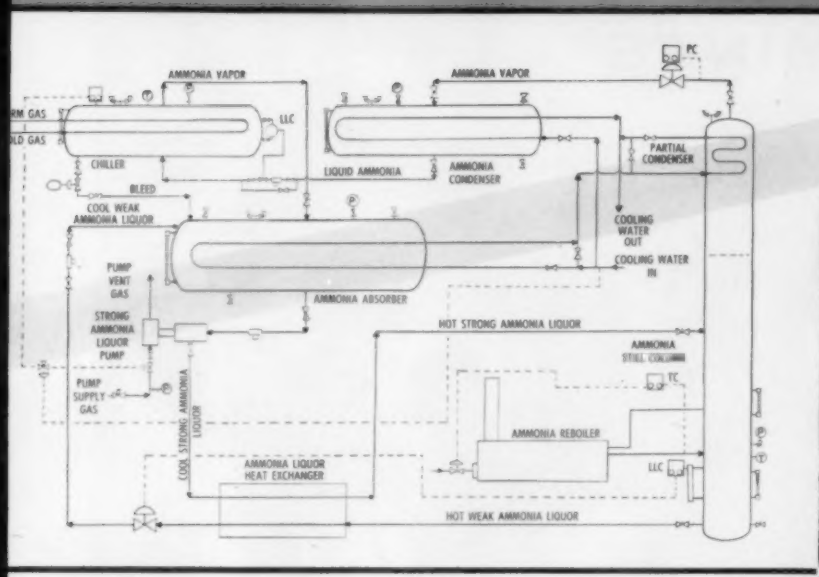
Ammonia Absorption Refrigeration Yields Low Dew Point Gas And Salable Liquid Hydrocarbons

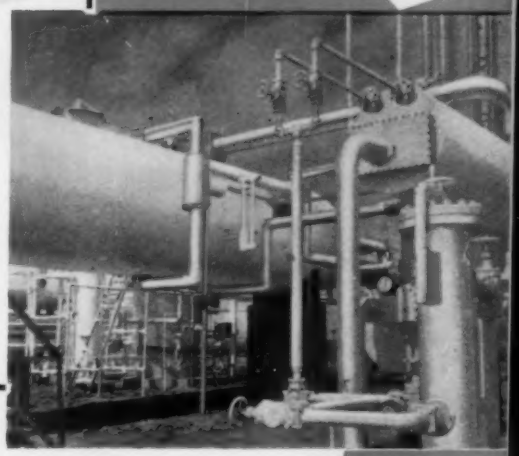
Early this year, Excelsior Oil Corp. (a subsidiary of Kansas-Nebraska Natural Gas Company, Inc.) put a new gas gathering plant on stream at Tyrone, Oklahoma. This plant, employing the new BS&B "COLD-FRAC" AMMONIA ABSORPTION REFRIGERATION Unit, is located on a major gas transmission line and was entirely designed, manufactured and constructed by BS&B on a "turnkey" basis. Here, in brief, are the important facts:

EFFICIENCY
OVER 60 YEARS
BS&B
RELIABILITY
ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

Your BS&B Man will be glad to give you detailed information on the new BS&B "COLD-FRAC" Ammonia Absorption Refrigeration Unit. Or, you may write to...

"Turnkey" Gasoline Plant...





THE OBJECTIVES:

1. To Achieve Maximum Dehydration Of The Gas Stream.
2. To Lower Hydrocarbon Dew Point To 0° F.
3. To Economically Extract Maximum Amount Of Salable Liquid Hydrocarbons Without Lowering Gas BTU Value Below Acceptable Limits.

The Company asked BS&B Engineers to analyze the objectives, and to recommend a suitable type plant.

THE RESULTS:

The low temperature plant was built "turnkey" by BS&B, incorporating Ammonia Absorption Refrigeration. This resulted in low water dew point, positive hydrocarbon dew point and the recovery of salable liquid hydrocarbons.

Ten Advantages Offered By BS&B "COLD-FRAC" Ammonia Absorption Refrigeration Units:

1. **Entirely Self-Operating.** Automatically Adjusts to Load Changes.
2. **Low Initial Cost.** Unit Is Entirely Skid-Mounted Except Ammonia Reboiler. Outside Construction — No Buildings Required.
3. **Low Cost Maintenance.** Liquid Pump Is the Only Moving Part.
4. **Operating Costs Vary** in Direct Proportion to the Load.
5. **Lower Operating Temperatures** Do Not Materially Decrease Capacity.
6. **Completely Closed System.**
7. **Chiller "Slop Over" of Liquid Refrigerant Causes No Problem.** (There is no compressor to cause worry about liquids in the suction.)
8. **Oil Lubrication Eliminated.** No Oil-Refrigerant Problem.
9. **Vibration Free.** No High Speed Reciprocating Machinery to Mount.
10. **Experts Are Not Required** to Operate and Maintain the Unit.

OTHER APPLICATIONS

BS&B Ammonia Absorption Refrigeration Units are applicable to any process that requires temperatures below ordinary atmospheric level, including all steps in the complete production cycle from the lease through the central plant to the refinery.

These units are constructed for heavy duty, continuous 24 hour-per-day, 365 day-per-year operation. Available in eleven standard sizes—with nominal capacities of up to 200 tons—these units have been designed to provide trouble-free, completely automatic operation under all conditions with minimum maintenance expense. Units larger than 200 tons in size offered on request.

* "COLD-FRAC" is a trade-mark of Black, Sivalls & Bryson, Inc.

BLACK, SIVALLS & BRYSON, INC.

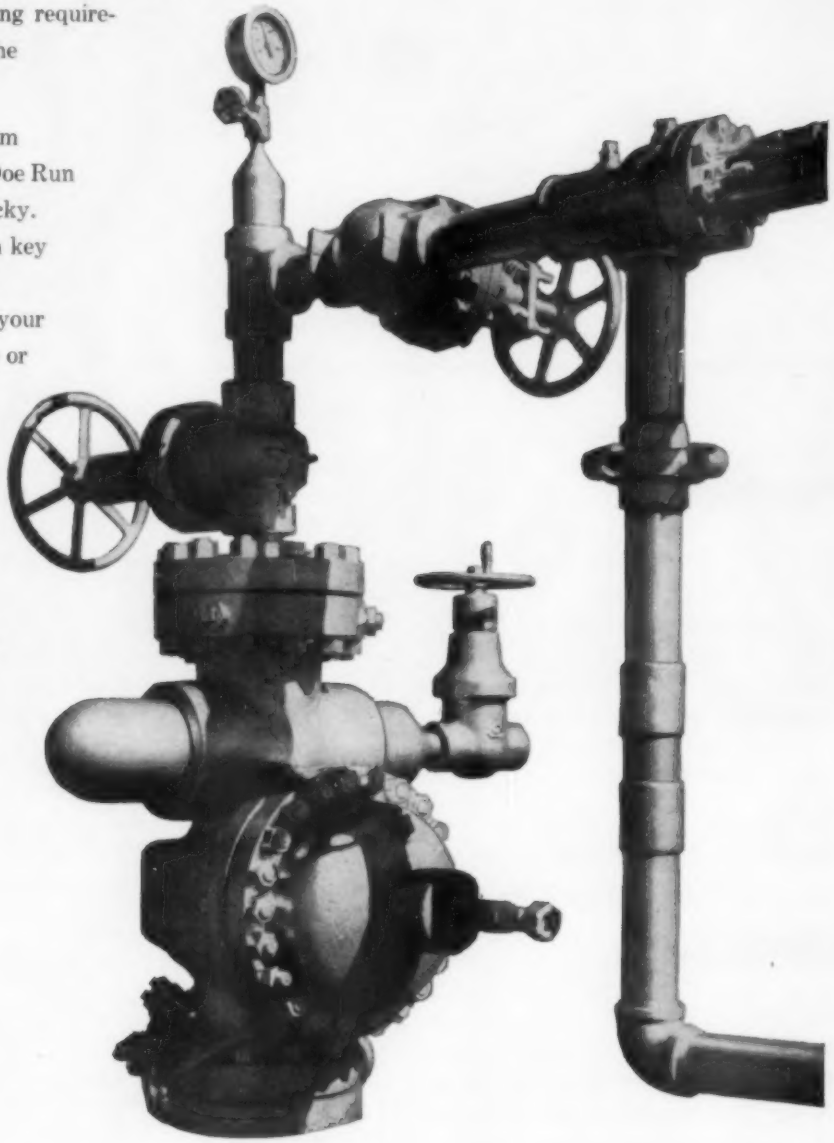
Oilfield Equipment Division, Dept. 1-A5A

P. O. Box 1714 Oklahoma City, Okla.

Mathieson
ETHANOLAMINES
are there

. . . in the quantity and quality specified and shipped to meet your operating requirements for gas scrubbing and the absorption of acidic gases.

Tank car, tank truck, and drum shipments are made from the Doe Run Plant at Brandenburg, Kentucky. Local stocks are maintained in key industrial areas. For technical information and samples, call your Olin Mathieson representative or write today.



for better gas scrubbing

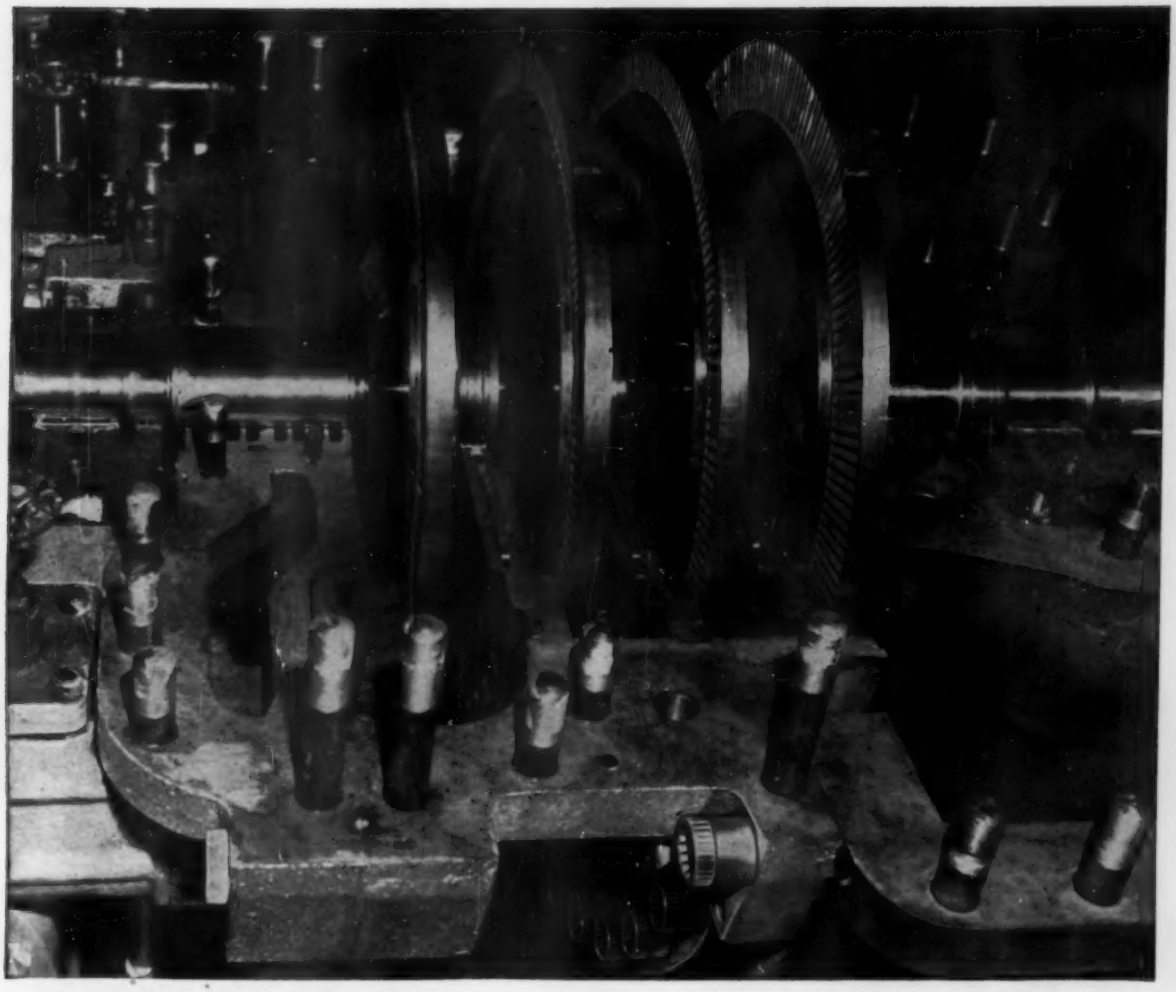
MATHIESON CHEMICALS
OLIN MATHIESON CHEMICAL CORPORATION
INDUSTRIAL CHEMICALS DIVISION • BALTIMORE 3, MD.

4546

MATHIESON

INORGANICS: Ammonia • Bicarbonate of Soda • Carbon Dioxide • Caustic Potash • Caustic Soda • Chlorine • Hydrazine and Derivatives • Hypochlorite Products • Muriatic Acid • Nitrate of Soda • Nitric Acid • Soda Ash • Sodium Chlorite Products • Sulphate of Alumina • Sulphur (Processed) • Sulphuric Acid

ORGANICS: Ethylene Oxide • Ethylene Glycols • Polyethylene Glycols • Glycol Ether Solvents • Ethylene Dichloride • Dichloroethyl ether • Formaldehyde • Methanol Sodium Methylate • Hexamine • Ethylene Diamine • Polyamines • Ethanolamines • Trichlorophenol • Surfactants



THE INSIDE STORY OF A MURRAY HIGH SPEED COMPRESSOR DRIVE TURBINE REVEALS THE REASONS FOR MURRAY'S UNIVERSAL ACCEPTANCE

A look at MURRAY'S rugged construction from the inside shows the husky shaft and heavy accurately formed discs with generous sized hubs designed to withstand the axial and radial stresses imposed by this type of service.

Large-dimension disc rims receive the specially contoured stainless steel blades with the Murray integral shroud. This insures smooth steam passages with maximum strength.

Short bearing spans insure smooth operation and eliminate the hazard of operating in critical speeds.

A look at the heavy flanges and husky bolting in the actual unretouched shop photo shown above bears out the extreme ruggedness that typifies every feature of Murray construction.

Our nearest representative will gladly help you solve your high speed compressor drive turbine requirements. Just write to Murray Iron Works Company, Burlington, Iowa for his name.

★ ★ **Murray Turbines** ★ ★

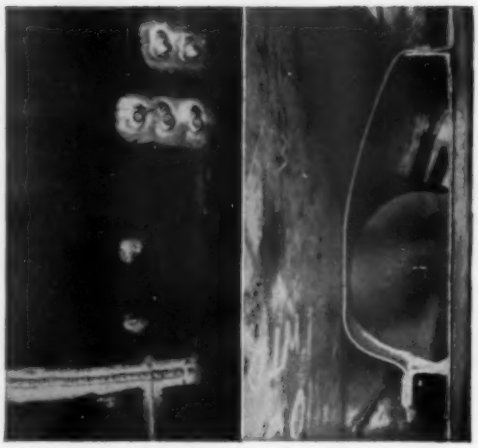
exhaustive tests prove: **36 YEARS FROM TODAY**

TUBESEALS* NOW IN FLOATING ROOF TANKS WILL OPERATE AS EFFICIENTLY AS THEY DO TODAY!

WE DOUBT this can be claimed for any other floating roof seal!

To determine the efficient life-expectancy of the Hammond Tubeseal in service, tests were made under the worst possible conditions to which a floating roof seal can be subjected. The Tubeseal was moved across very rough rivet heads, erection burrs and abrasive weld surfaces, for a total travel of 70,000 feet. This is equivalent to a normal wear of *more than 36 years in actual service.* Moreover, as the tests were run dry, there was the added disadvantage of the absence of lubricating effect normally created by wetted surfaces. Upon completion of these rigorous tests, the scuff band had only worn through the ribs and had barely penetrated through the material, leaving two-thirds of the stock intact; proof that the Tubeseal is unimpaired after traveling 70,000 feet.

The 36 year life-expectancy of a Hammond Tubeseal assumes no mechanical accident and is arrived at in the following manner: Each year a floating roof, in normal service, makes about 48 trips to and from top and bottom of tank. The roof of a 40 foot tank, therefore, will travel 1920 feet per year. Assuming 1920 feet of travel per year (based upon full depth of travel) and applying our accelerated wear test, the Tubeseal will be serviceable for at least 36 years 5½ months.



THE TUBESEAL TEST:

total travel	70,000 feet
travel over vertical weld	46,400 feet (on same line)
Horizontal welded seam crossed	21,200 times
Flat head rivets crossed	63,600 times

CONDITION OF TUBESEAL AFTER TEST: Scuff band had worn through ribs and had barely penetrated into the main material, leaving ⅔ of stock intact.

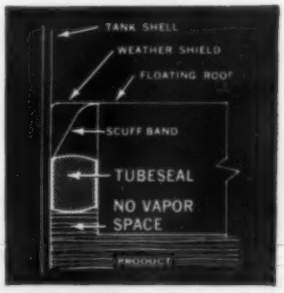
Tests were conducted dry with no aid of lubricant normally resulting from stored product.

Photos show projections used for test. Included are 16" of ⅜" horizontal weld—24" of sharp, irregular vertical weld—2 erection burrs—3 ¾" flat head rivets and 2 ¾" cone head rivets.

THE HAMMOND TUBESEAL
is the most efficient and positive seal known.

it features:

no moving parts
no mechanical maintenance
climate proof
non-corrodible
can operate to bottom of tank or above the top
no vapor space below the seal
entire circumference has tight seal under pressure at all times
longer working life expectancy



NO ROOM FOR VAPORS
NO EVAPORATION
NO CORROSION

patented* ***Write for bulletin TS*

HAMMOND TUBESEAL — THE MOST EFFICIENT AND POSITIVE SEAL KNOWN

HAMMOND IRON WORKS

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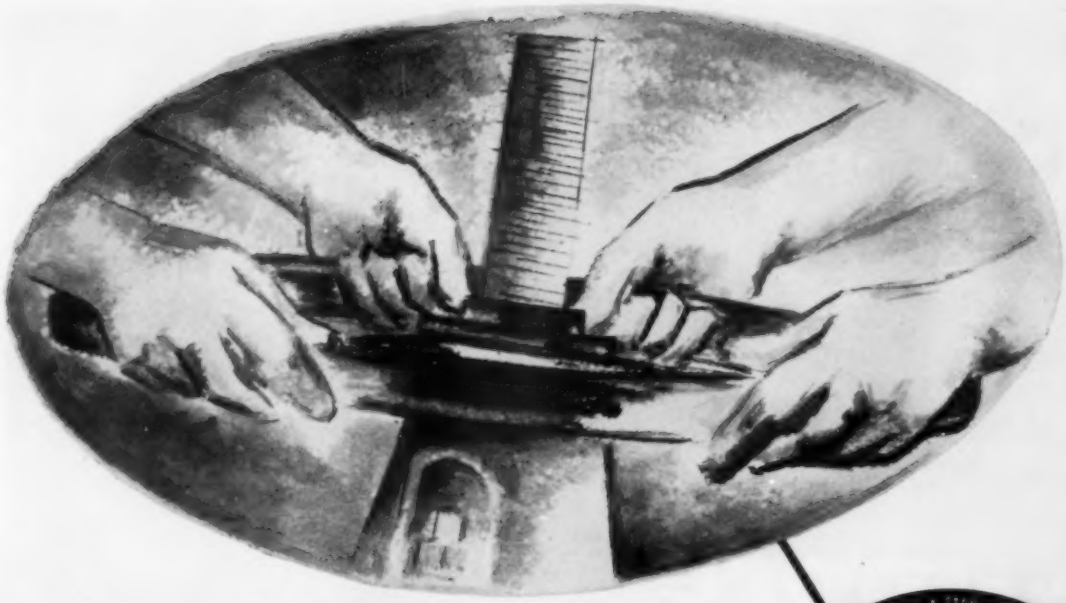


four hands or . . . one finger

LimiTorque push button operation saves thousands of man hours

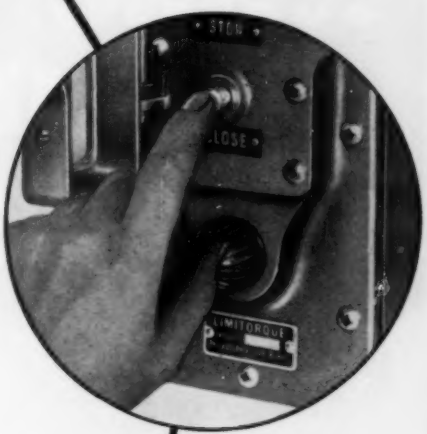
Yes, it's just as simple as that: "one finger instead of two to four hands" . . . because *LimiTorque* opens and closes any type of valve in a fraction of the time required for hand operation. It is absolutely dependable and safe, even when pressures are so high that manual operation is almost impossible . . . when the valve is exceptionally hot . . . and where its location is hazardous or inaccessible . . . Instant, positive operation is given to valves located even miles away, and all that is required is the mere push of a button.

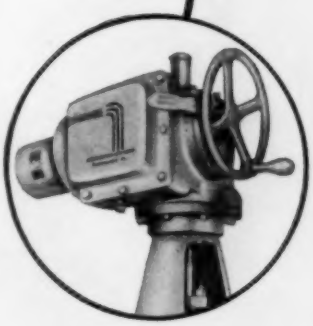
Of course, *LimiTorque* offers a number of exclusive advantages in design and construction, which not only give dependable, safe and speedy performance, but which are your *guarantee* against damage to valve stems, seats, discs, plugs, or gates . . . not to mention possible physical injury to operators.

LimiTorque may be supplied for actuation by any power source, such as electricity, steam, water, gas, oil or air—and it is readily adapted for micro-wave control.

Thousands upon thousands of these "time-tried and tested" *Valve Operators* are in continuous use, all over the world.

For complete information, send for Catalog L-550—on your Business Letterhead, please.





LimiTorque®

PHILADELPHIA GEAR WORKS, INC.
ERIE AVE. & G STREET, PHILADELPHIA 34, PENNA.
Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID MIXERS • FLEXIBLE COUPLINGS
Limitorque Corporation • Philadelphia

...more quality proved POWELL VALVES

Fig. 3059G—300-Pound Steel Lubricated Plug Valve. Bolted Gland type. Gear Operated. Sizes 6" to 12".

Fig. 2467—Small Stainless Steel Gate Valve for 300 Pounds W.P. Outside screw stem and bolted yoke.

Fig. 86190—Steel "LPG" Globe Valve for 400 W.O.G. For services that demand the use of Steel Valves.

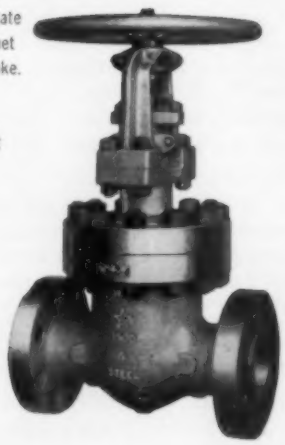


Fig. 1303—1500-Pound Steel Gate Valve with bolted flanged bonnet and outside screw stem and yoke.

made with quality proved materials

Consult your Powell Valve Distributor for full facts about quality proved bronze, iron, steel, and corrosion-resistant valves. For every flow control problem—there is a Powell Valve to solve it . . . *better.*

THE WM. POWELL COMPANY, CINCINNATI 22, OHIO . . . 111th YEAR

CRUSHPROOF...LEAKPROOF...FLEXIBLE FOR HANDLING VOLATILES...GASES

PRESSURES TO 200 PSI . . . SWIVEL FLANGE FOR EASY INSTALLATION

Stainless steel lined metal hose for rugged flexibility . . . covered with tough rubber for absolute leakproof security . . . that's Penflex Suction and Discharge Hose. It's lighter in weight than any other comparable competitive hose . . . easy to handle with swivel flange that allows installation in any position without turning entire hose to meet bolt holes. End fittings are made of steel to meet specifications of refinery engineers.

Penflex Suction and Discharge Hose has been thoroughly tested and is used by leading refineries and chemical plants throughout the nation. It is proved and approved the all-purpose hose for oil, gasoline, solvents, corrosive chemicals and other volatiles and liquids. Available in sizes 2" to 12" I.D. in galvanized steel, stainless steel and bronze pressure carrier. Write for complete details.

PENNSYLVANIA FLEXIBLE METALLIC TUBING COMPANY
7213 POWERS LANE, PHILADELPHIA 42, PA.

Branch Sales Offices: Boston New York Chicago Houston Cleveland Los Angeles
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FLEXIBLE TUBING, AUTOMATIC BARREL FILLERS, PNEUMATIC RIVET PASSERS, ACCESSORIES AND FITTINGS

To help YOU make more profits
by getting better results

P.E.S.A. *members make each year*

THREE MILLION SERVICE CALLS

Keen executives and engineers of the oil industry know how to appraise the value of specialized technical services.

Specialized service companies last year made over 1,900,000 service calls, furnishing scientific, engineering, technical, and consulting services. This is conclusive proof of the time-saving and money-saving advantages of having specialized operations performed by the highly trained specialists of service companies.

Manufacturers made around 600,000 service calls last year, servicing their products — proof that the interest of the maker does not stop with the shipment of his products and proof too that the user appreciates service that helps him get the job done quicker and more economically.

Supply companies made nearly 600,000 service calls last year — proof of the importance of their advice and service on the products they sell and on which they stake their name and their investment.

In most other industries the preponderance of service is performed by the operating company itself. In the oil business the services required are so technical and require such costly equipment that it would be uneconomical for each operator to maintain crews and specialized equipment. Thus, it is natural that service companies handle the service work for many operating companies. Likewise, operators have found that it is good practice to depend on the consultation and services manufacturers and supply companies give.

These service calls are growing in number faster than the industry due to rapid technological advancement. That they will continue to do this is manifested by the growing investments in research by the service companies, manufacturers and supply companies. This heavy investment in research is necessary in order to produce the new equipment and methods required by the dynamic and progressive oil industry. **No matter what the cost or how urgent the need, the members of P.E.S.A. will be ready . . . as always.**

PETROLEUM EQUIPMENT SUPPLIERS ASSOCIATION

P.E.S.A.*

* PETROLEUM EQUIPMENT SUPPLIERS ASSOCIATION

ONE SIGNATURE
ONE RESPONSIBILITY
ONE HIGH STANDARD

INVESTIGATE PRITCHARD'S
SINGLE RESPONSIBILITY CONTRACT FOR YOUR NEXT CONSTRUCTION PROJECT

Let a Pritchard Single Responsibility Contract be the key to a successful construction project for you. Whether you are contemplating building a new plant, expanding or modernizing present facilities, Pritchard has a lot to offer you.

One Signature! You sign one contract with one firm; not a separate contract for each phase of the project. Pritchard handles everything including the design, engineering, purchasing and construction. The result is a saving to you in time and money. Things move rapidly. Design and Engineering are carefully coordinated. You benefit from the savings in quantity purchasing. Construction proceeds without costly delays.

One Responsibility! Responsibility for your complete satisfaction rests with Pritchard and Pritchard alone. This includes all phases up to and including final testing.

One High Standard of Performance! You know, before the project begins, exactly what it will cost. Specifications are established and you get what you pay for—nothing less. Pritchard gives you a firm guarantee of proper operation and maximum efficiency. There is only one standard of quality and performance with Pritchard: the very best.

YOUR INQUIRY IS INVITED

SERVING THE GAS, PETROLEUM, CHEMICAL, PETROCHEMICAL, PULP, AND PAPER INDUSTRIES AND THE POWER PLANT NEEDS OF INDUSTRY AND CORPORATE UTILITIES.

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Grease
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TRANSPORTATION HOSE

Barge Unloading
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PRODUCTION HOSE

Mud Pump Suction
Rotary Drilling
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COUPLINGS AND ACCESSORIES

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Stocked in the Mid-Continent Area by JONES & LAUGHLIN STEEL CORPORATION, Supply Division P.O. Drawer 2481, Tulsa 2, Okla. and the J & L Store in YOUR field.

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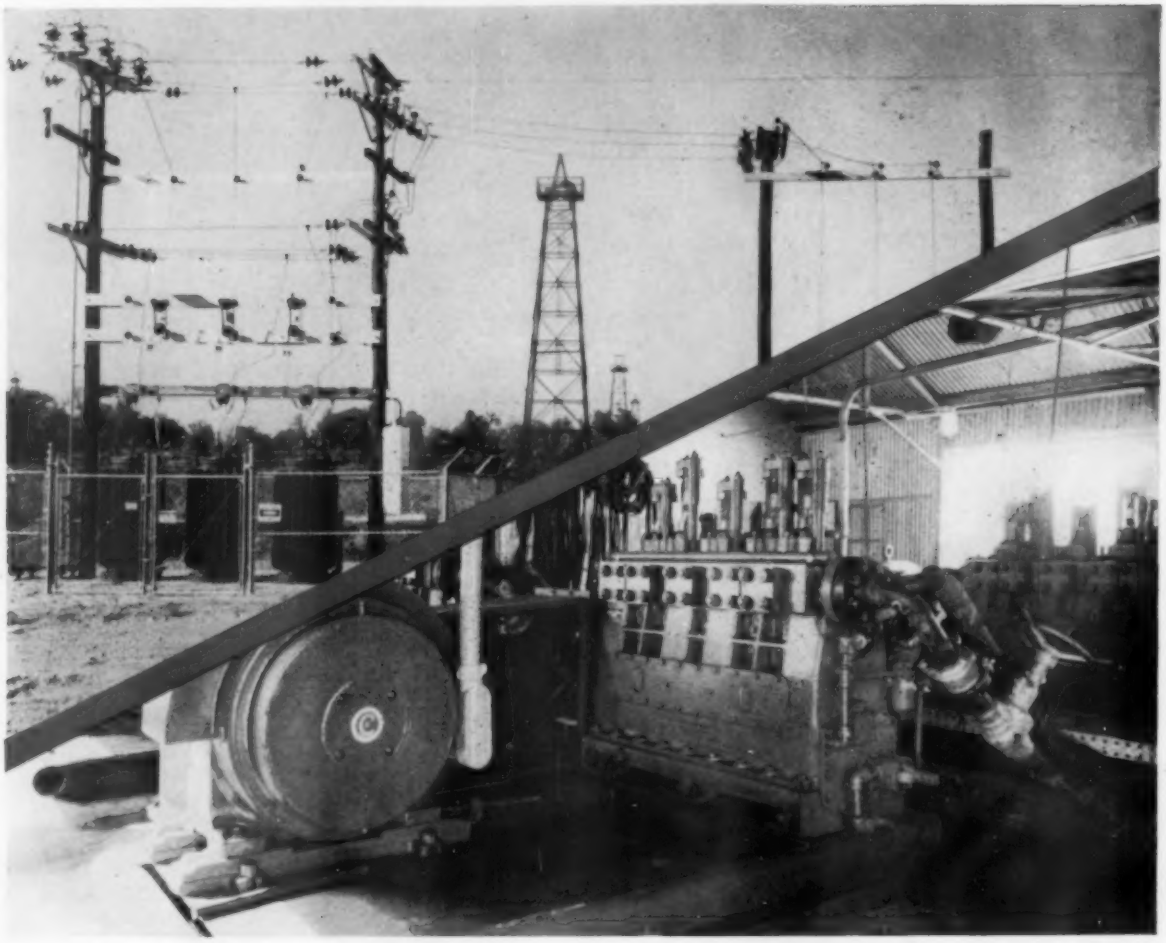
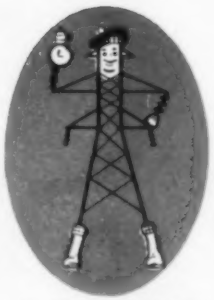
Stocked on the West Coast by HENDRIE BELTING & RUBBER CO. 405 Towne Ave., Los Angeles, Calif. PACIFIC COAST RUBBER COMPANY 51 Main St., San Francisco, Calif.

WATER FLOODING OPERATIONS ARE TURNING MORE AND MORE TO UTILITY ELECTRIC POWER



Progressive Management Finds the Solution

Are you doing water flooding? Do you have plans to do water flooding? If so, don't settle on the power equipment until you have carefully investigated what UTILITY ELECTRIC POWER can do for you. The sales engineer of your Utility Electric Power Company has many actual case records which demonstrate that it is more efficient . . . more economical to use Electric Power. Be modern . . . be progressive . . . enjoy all the benefits of truly automatic, push-button power – Use UTILITY ELECTRIC POWER.



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PETROLEUM ELECTRIC POWER ASSOCIATION

P. O. BOX 2771 DALLAS, TEXAS

The Rockwood Dualsteel Union was made especially to handle highly corrosive material

There's nothing to worry about

It's a ROCKWOOD DUALSTEEL UNION!

Rockwood's Dualsteel Unions stand up to wrench abuse and overcome galling. The reason — Dualsteel's greater Brinell hardness.

Rockwood Dualsteel Unions are made of a new special alloy steel. This special alloy steel cannot be welded, it's tougher, more resistant to corrosion. Straight waterway eliminates corrosion and erosion at seat joint. You get greater strength without bulk!

The entire union is completely "Rockwoodized", the threads being protected by "Rockwoodizing" after having been machined. This process plus the special alloy make the Dualsteel Union ideal for the handling of corrosive material.

But there are even more reasons why Rockwood Dualsteel Unions are what you're looking for. All Dualsteel Unions are individually air tested under fluid. Their ultimate strength is 85,000 pounds per square inch.

If you want a union that will resist corrosion and overcome galling . . . a union that has more advantages — and none of the weakness of solid steel constructed unions — you want Rockwood's Dualsteel Unions.

For complete information fill in the coupon below. We'll send all the data.

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ARMCO

ALLOY STEEL made to fit the needs of the WEST

by the West's only producer

HIGH STRENGTH and AIRCRAFT QUALITY GRADES

available in

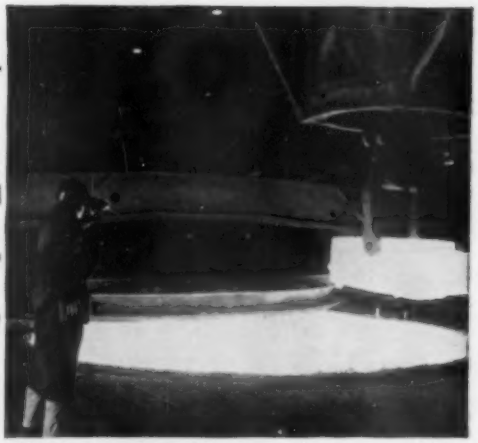
STRIPS • PLATES • ROUNDS • SQUARES • FLATS
ROUND-CORNERED BARS AND BILLETS • BLOOMS

Marvels of modern metallurgy, Sheffield Alloy Steels provide strength-to-weight ratios that (in the higher tensile-strength brackets) make steel actually lighter for the load it carries than any other commonly used metal.

A fact literally worth its weight in gold! For example, excess weight in aircraft costs around $500 a pound in terms of maintaining strength and economical operation. That's just about the going price of gold.

Not only in aircraft, but in countless other steel uses, Sheffield Alloy Steels add strength without adding weight. That means better products and better values for everybody. To bring this about, alloy steels must be made precisely to formula. Sheffield makes it a sure thing — with the most advanced testing procedures at every step from furnace to finished steel.

If you're a manufacturer of any product using alloy steels, you'll find the metal tailored to your needs in Sheffield High-Strength, Shef-Ten, Forging and Aircraft grades. Sheffield's strategic locations make possible service and buying advantages which will interest you. Get in touch with us.



Constant control of temperatures to precise specifications is a vital part of making alloy steels. The metallurgist above is making a quality control check of an ingot, using a sensitive optical pyrometer.

Micro-examination of steel samples is one of many checks Sheffield uses to guard the quality of Sheffield Alloy Steels.

The densitometer gives spectographic analysis of steel samples—measuring the density of the spectrum lines to determine the amount of each chemical element present.

SHEFFIELD DIVISION ARMCO STEEL CORPORATION

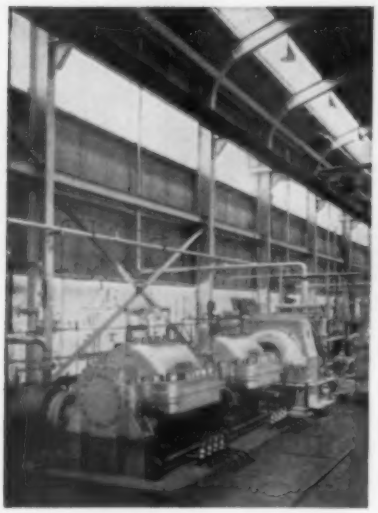
SHEFFIELD PLANTS: HOUSTON • KANSAS CITY • TULSA — OFFICES IN PRINCIPAL CITIES

Yes, Virginia, gasoline does cost less than it did 30 years ago. (Before taxes, of course.) Most oilmen know this story; we know how the power in regular gasoline has climbed from 50 octane in the mid '20s to over 90 today. We know, too, what a fantastic value gasoline represents as a commodity. An industrial worker labored 23 minutes to buy a gallon in 1926; today he works just 6½ minutes for a better product. *We* know—but the public does not. What are *you* doing to tell them? **SHELL OIL COMPANY**

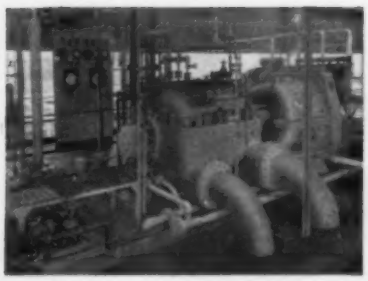
Six IR turbo-compressors help increase capacity of

GULF

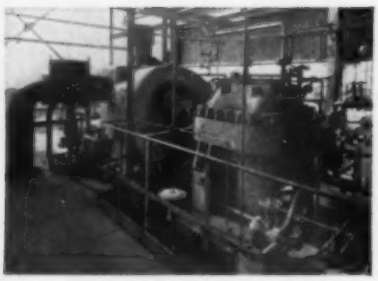
New ethylene plant of the Gulf Oil Corporation, Port Arthur, Texas. Stone & Webster Engineering Corporation, designers and constructors.



Steam-turbine driven I-R tandem centrifugal compressors in ethylene refrigeration service. Rated 3270 inlet cfm at 270 psia discharge pressure.



I-R gas compressor for handling feedstock. Rated 6230 inlet cfm at 252.7 psia discharge pressure. Driven by 4300 hp steam turbine.



I-R gas compressor, rated 11,400 inlet cfm at 264.7 psia discharge pressure. In propane refrigeration service. Steam-turbine driven.

AIR AND GAS COMPRESSORS for the process industries

Ingersoll-Rand builds a complete line of reciprocating and centrifugal compressors. Pressures range up to 35,000 psi and capacities up to 255,000 cfm. These machines are now serving in such important processing as synthesis of methanol, ammonia, rubber and toluol; hydrogenation and dehydrogenation; polymerization; and alkylation. Electric, steam, gas turbine, gas-engine, diesel and belt drive.

World's Largest Ethylene Plant

to over a million pounds a day!

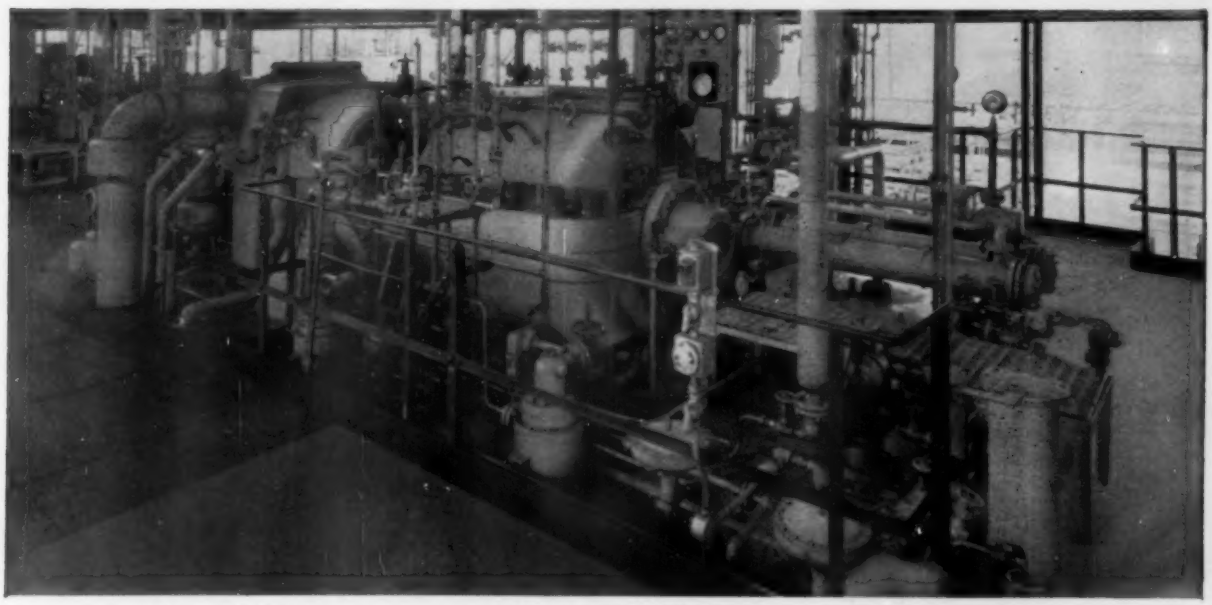
Serving Gulf Oil's Port Arthur No. 2 unit, these Ingersoll-Rand compressors are employed for compressing process gases and refrigerants

WHEN THE second ethylene unit of the Gulf Oil Corporation at Port Arthur, Texas, went on stream last year, it increased the plant's capacity by 220 million pounds a year. Now, the world's largest producer of commercial ethylene, it is supplying a growing number of customers in the Texas Gulf Coast area.

Of the six Ingersoll-Rand centrifugal compressors installed in the new No. 2 plant, three units are in process gas service. They are delivering a mixture of refinery gas and gas from the cracking furnaces to the recovery and separation section of the unit. The remaining three I-R compressors are handling ethylene and propane for cascade refrigeration in the separation section.

For exacting operations such as these, Ingersoll-Rand compressors have for years proven unusually successful. They meet the most rigid requirements of the process industries, in which millions of horsepower have now been installed.

Your I-R engineer will welcome the opportunity to help you solve your air or gas compression problems.



Close-up of I-R gas compressor. Steam-turbine driven, rated 19,100 inlet cfm at 76.2 psia discharge. For handling gases from cracking furnaces.

Ingersoll-Rand

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R-P&C VALVES

DESIGNED FOR DEPENDABILITY

BAR STOCK VALVES FOR CLOSE CONTROL, ESPECIALLY SUITED FOR CLOSE-COUPLED INSTALLATIONS

• rated for pressures up to 10,000 PSI •

• The bar stock valve, designed originally by R-P&C engineers, is really a versatile performer. First developed for instrument use, bar stock valves have proven to be the answer to valve problems of many different kinds. Designed for close control, they are ideal for throttling service. Their compactness makes them the natural choice for crowded locations such as panel boards. Economically priced, they serve in many applications as general purpose valves. And they are built in a wide variety of materials—can withstand extremely high temperatures and pressures.

For example, the **Fig. 1040-A Valve** shown here, made from carbon steel, is rated for 10,000 psi at 150°F. Each of these valves is individually tested at 15,000 psi before it leaves the factory.

R-P&C's complete line of bar stock valves includes constructions in 12-14 chromium stainless steel, 18-8 molybdenum stainless steel and bronze. Sizes range from ⅛" to 1" in globe and angle styles with female ends, male and female ends, or male union ends. For extremely severe throttling services, R-P&C bar stocks can be supplied with stellite discs for extra abrasion resistance.

Your R-P&C distributor carries not only a complete line of bar stock valves but also a wide selection of gate, globe, angle and check valves in bronze, iron, and cast and forged steel. You will find the answer to your valve problem in his selection.

FREE WALL CHART
"How to Protect Your Valves"
Installation pointers, operating tips, clues to longer valve life. They are all on this 22" x 17" wall chart. Write for your free copy.

R-P&C VALVE DIVISION
AMERICAN CHAIN & CABLE

Reading, Pa., Atlanta, Boston, Chicago, Denver, Detroit, Houston, New York, Philadelphia, Pittsburgh, San Francisco, Bridgeport, Conn.

ACCO

SOLA FLEX®

THE FINEST IN EXPANSION JOINTS AND BELLOWS

THE SOLA-FLEX LINE is the most comprehensive in the world. It includes many basic types of expansion joints—convoluted, U-span, rectangular, and others. Sizes range from ½ in. to 35 ft in diameter. Pressure ranges run from complete vacuum to 3500 psi, and bellows have been built for service from—300 F to 2000 F. Materials used include all types of steels and a variety of high alloys.

Pipe expansion problems increase with higher pressures, temperatures and smaller space. Sola-Flex joints provide the answer—with economy and efficiency. Write for catalog today. Dept. D-26, Solar Aircraft Company, San Diego 12, California.

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Designers, Developers and Manufacturers • Gas Turbines • Aircraft and Missile Components • Bellows • Controls • Coatings • Metal Alloy Products

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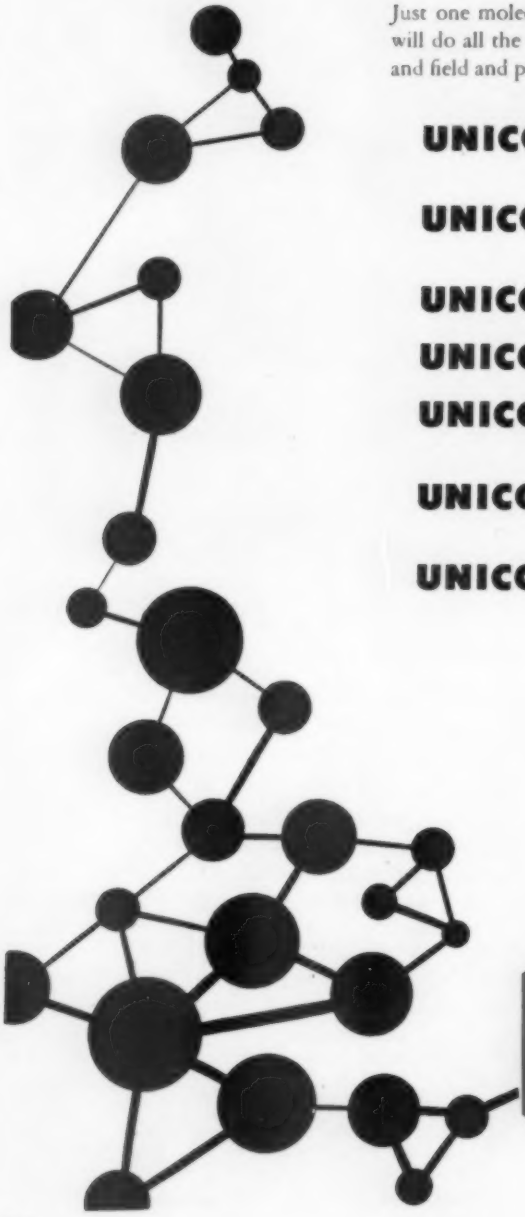

Just one molecule of Unicor to one million molecules of pipeline product will do all the things listed below. Unicor has been tested in both laboratory and field and proved to be superior to any other form of corrosion preventive.

UNICOR® prevents both aerobic and anerobic corrosion. Your tanks, vessels and pipelines are protected whether full, half-full or empty.

UNICOR is oil soluble and eliminates need for addition of destructive water. It prevents rusting caused by unavoidably entrained or dissolved moisture.

UNICOR is slime-detergent and anti-fouling. The water-repellent film it forms on pipe interiors sheds corrosive droplets.

UNICOR cuts downtime to a minimum, reduces filter replacement and the use of scrapers by at least one-half.

UNICOR will not interfere with action of other useful additives such as tetraethyl lead, antioxidants and dyes. It is approved for use in Air Force and Navy jet plane fuel.

UNICOR is added at only one point. Its beneficial effect will extend to pipelines, storage tanks, tankers . . . even to consumer equipment when added at the refinery.

UNICOR is economical, costing only about $0.001 per bbl. of pipeline product. It has been approved for use in common carrier pipelines.

Sold exclusively by Universal Oil Products Company. For samples and information, write to:

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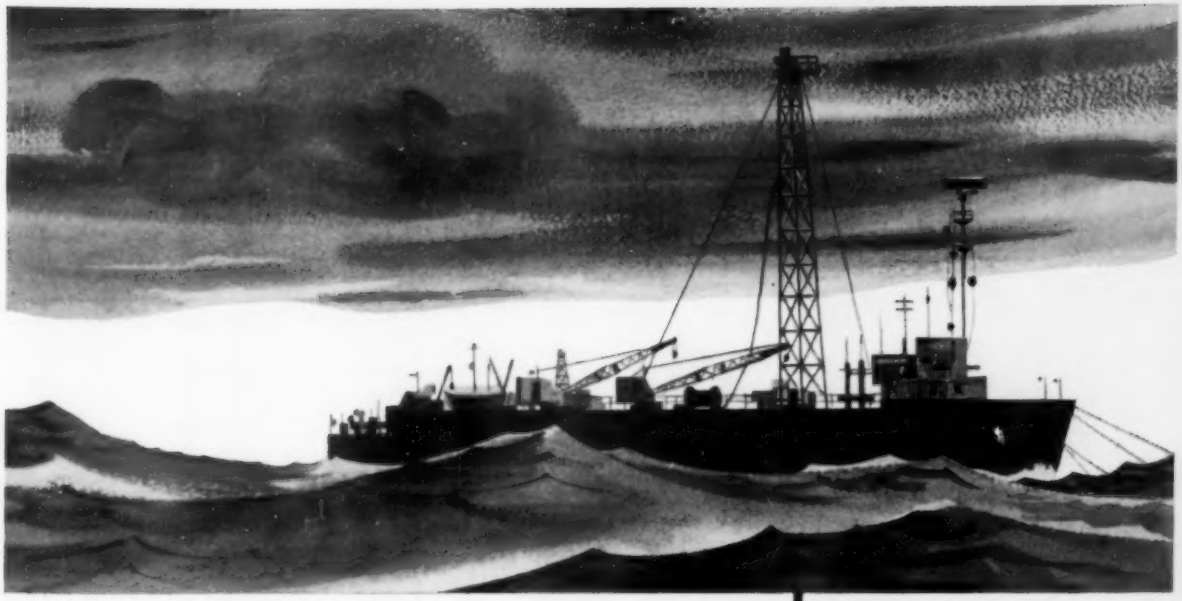


Floating rig makes hole faster -good weather or bad

Brand-new method of deep-water drilling made practical by Allison TORQMATIC Drive

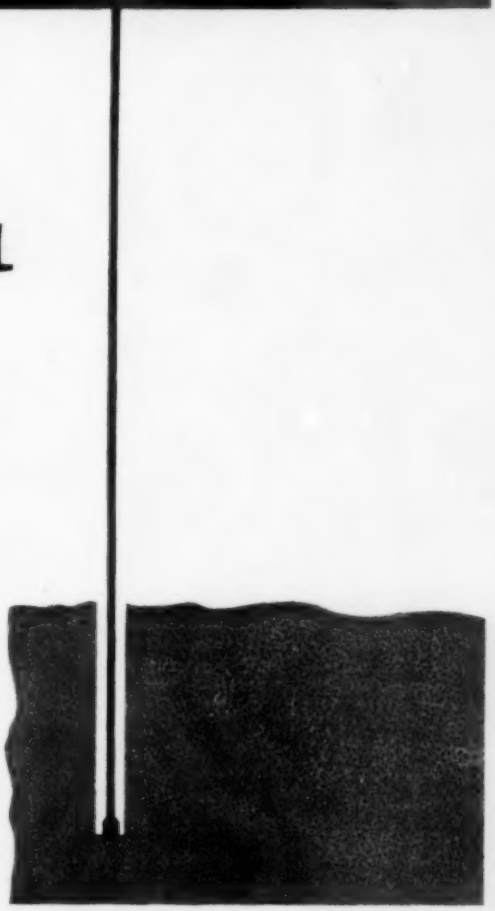
Up till now it couldn't be done. Bad weather meant stopping operations in deep-water drilling. Operators had no way of maintaining correct bit pressure on the bottom of the hole.

This revolutionary slim-hole rig designed by Hopper Machine Works solved the problem neatly with a modified TORQMATIC TC-855 Converter.

Now – in heavy ground swells, the TORQMATIC Converter automatically compensates for movement of the barge, maintaining correct tool pressure.

When other rigs have to quit because of rough water, this TORQMATIC-equipped rig goes right on drilling.

If you want oil-field equipment with more utility, more speed – get the Allison TORQMATIC story. See your equipment dealer, or write: Allison Division of General Motors, Box 894R, Indianapolis 6, Indiana.



GM TORQMATIC

Allison TORQMATIC DRIVES

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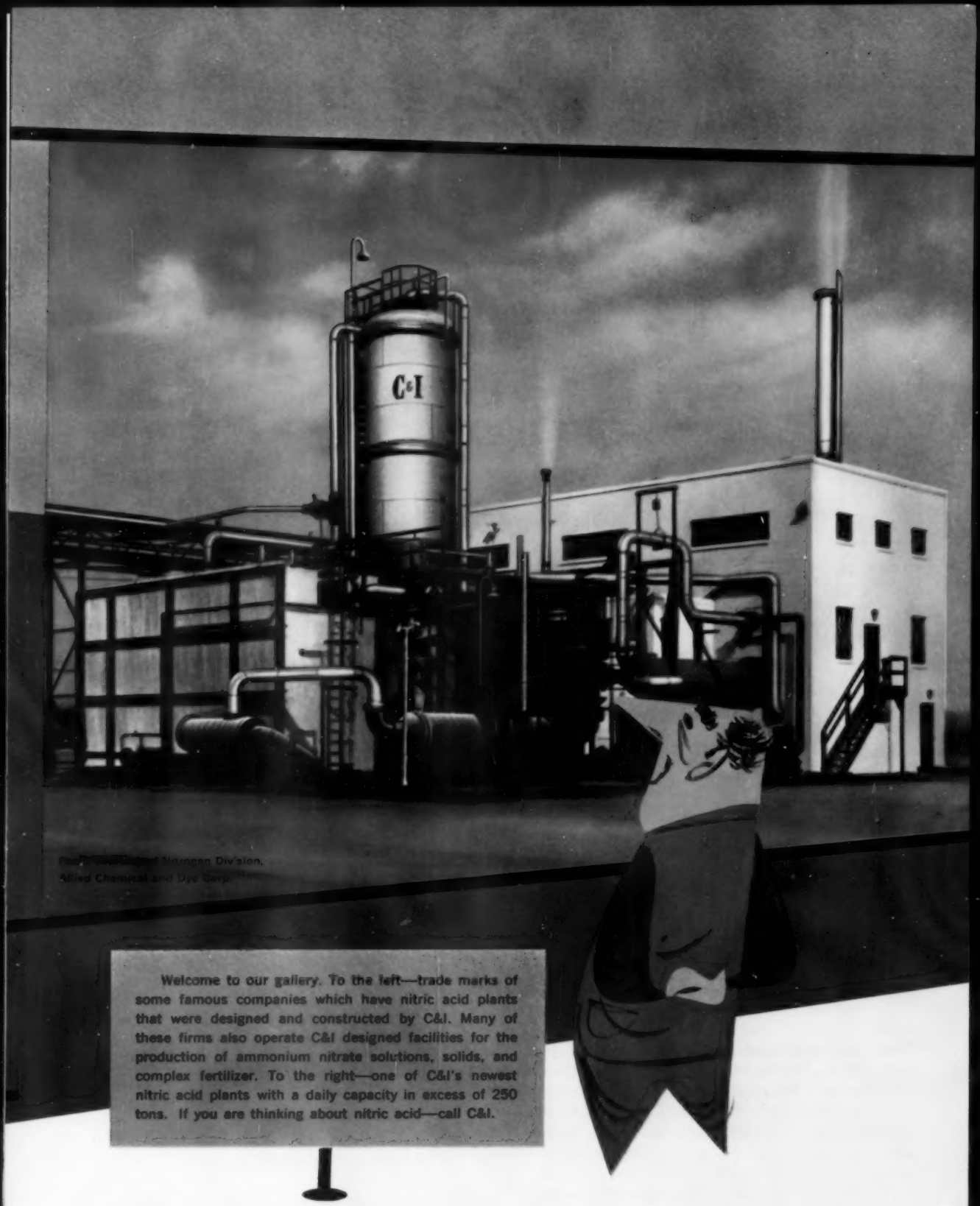


Welcome to our gallery. To the left—trade marks of some famous companies which have nitric acid plants that were designed and constructed by C&I. Many of these firms also operate C&I designed facilities for the production of ammonium nitrate solutions, solids, and complex fertilizer. To the right—one of C&I's newest nitric acid plants with a daily capacity in excess of 250 tons. If you are thinking about nitric acid—call C&I.

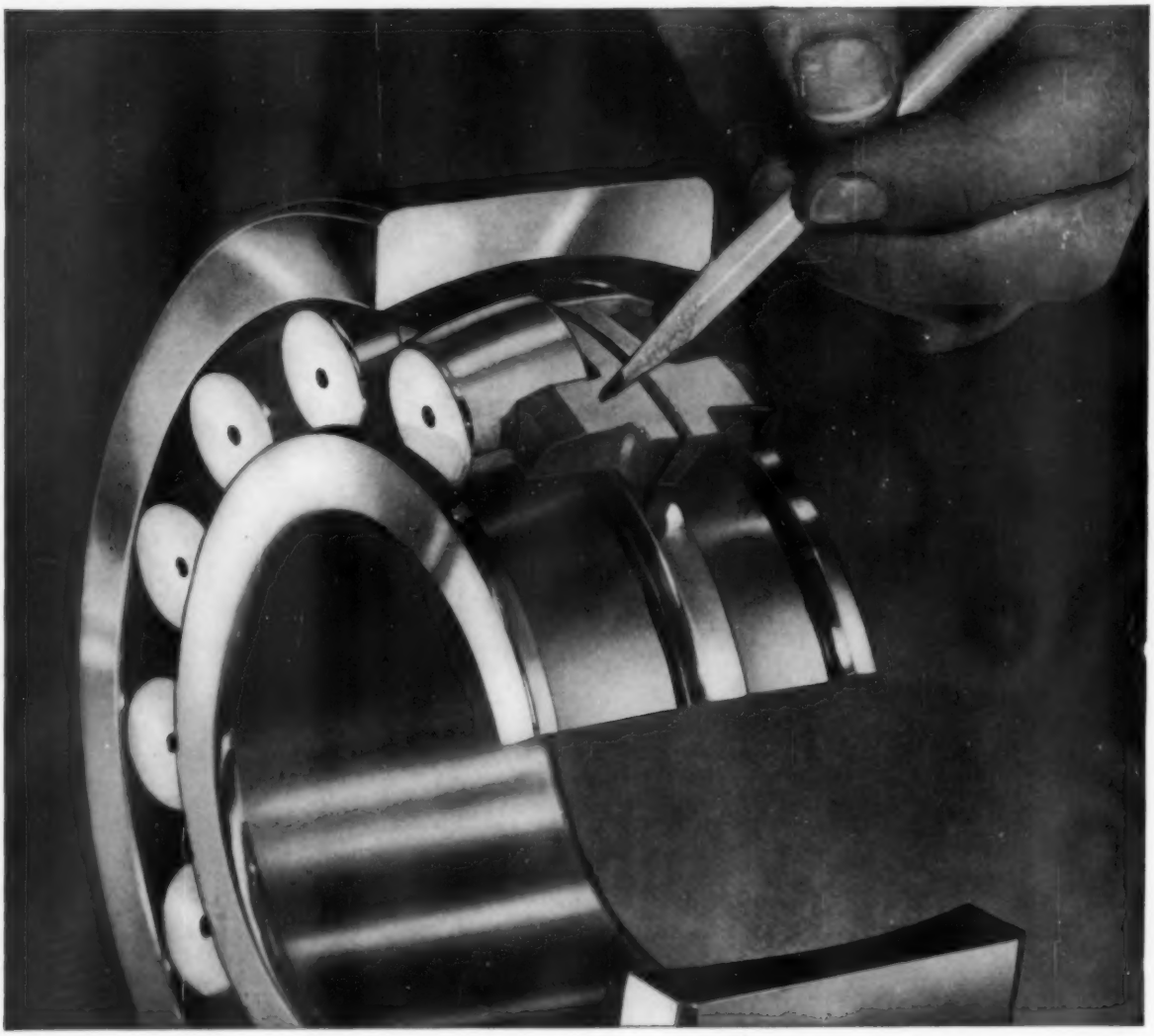
C I

THE CHEMICAL AND INDUSTRIAL CORP.

CINCINNATI 26, OHIO

Designers and Builders of Plants for the Processing of Ammonia • Available Throughout the World

TORRINGTON *SPHERICAL ROLLER* BEARINGS



Land-riding cages for longer life!

These fully machined cast-bronze, land-riding cages—one for each path of rollers—are important performance builders in TORRINGTON'S Spherical Roller Bearings. The one-piece retainers keep the rollers perfectly aligned at all times, even under conditions of shock load and sustained speeds. Lubrication is more effective, too, as the lubricant has easy access to vital points of contact between rollers and races.

This feature is typical of TORRINGTON'S design, made possible through long experience in serving industry with the finest in precision bearings. That's why it pays to look to TORRINGTON first when your application calls for Spherical Roller Bearings. They're available from stock with either straight or tapered bore, for shaft or adapter mounting.

THE TORRINGTON COMPANY
South Bend 21, Ind. • Torrington, Conn.
District offices and distributors in principal cities of United States and Canada

TORRINGTON BEARINGS

Spherical Roller • Tapered Roller • Cylindrical Roller
Needle • Ball • Needle Rollers

New Forward Control Design provides more space because the engine is behind you. It puts a 74" pickup box on 81" wheelbase—record-breaking cargo space per inch of wheelbase. This efficient design makes maneuvering through rough terrain faster and safer.

Why the New Forward Control 'Jeep' FC-150 saves time and money in oil and gas operations

All-Wheel Traction. With the extra traction of its 4-wheel drive, the FC-150 travels through mud and sand, climbs inclines as steep as 65%, in good weather or bad. Yet, it shifts easily into 2-wheel drive for highway travel at top legal speeds.

On job after job the all-new Forward Control 'Jeep' FC-150 speeds tough assignments with savings of time and manpower. That's because it's made to order for the oil and gas industry.

Here's a 4-wheel drive truck that gives you maximum cargo space on minimum wheelbase. It maneuvers through rough, rugged country, with crew and equipment, where ordinary trucks call it quits. Riding comfort!—you have to test drive it to believe it! There's plenty of head, leg, and shoulder room! The all-new Safety-View cab lets you see terrain as close as 6 feet from the front bumper. It combines with the new wrap-around windshield—largest in the FC-150 weight class—for up to 200% greater forward visibility. And with power take-off, the FC-150 has the all-around versatility to operate a wide variety of special equipment from mobile drills to winches or trenchers.

The new 'Jeep' FC-150, G.V.W. 5,000 lbs., is powered by the economical, performance-proved engine that made 'Jeep' vehicles famous. It combines with a new 16-gallon gas tank to give you a cruising range of up to 300 miles on just *one* filling. See your 'Jeep' dealer for a demonstration today!

There's a 4-Wheel-Drive 'Jeep' vehicle for your job!

Universal 'Jeep'

'Jeep' Truck

'Jeep' Utility Wagon

'Jeep' / *Forward Control*

4-Wheel-Drive **FC-150**

WILLYS... world's largest makers of 4-Wheel-Drive vehicles

WILLYS MOTORS, INC., TOLEDO 1, OHIO

Top Performance at Rock Bottom Cost

WITH THE

GUIBERSON

TYPE B TUBING SPIDER

Stock sizes 1" to 3"; spiders are available on special order for 2" x 1" and 2 ½" x 1 ¼" parallel strings.

The Guiberson Type "B" tubing spider is a fast-handling, lightweight tool that can be handled by one man if necessary—and the cost of the "B" is lightweight, too. No other spider in its class offers greater economy, either initially or in the long run.

Despite its exceptionally light weight, the Type "B" spider will hold the longest string, and release instantly without sticking when you pick up. All slips fit the same bowl, and the "B" will not distort or damage tubing. Self-equalizing slips with hard, sharp teeth, give full, large-area contact, assuring positive grip, better load distribution and perfect release.

For positive performance, maximum protection, amazing handling ease and surprisingly low cost, you can count on the sure-grip "B" Tubing Spider.

THE

GUIBERSON

CORPORATION

ESTABLISHED 1919
DALLAS, TEXAS
U. S. A.

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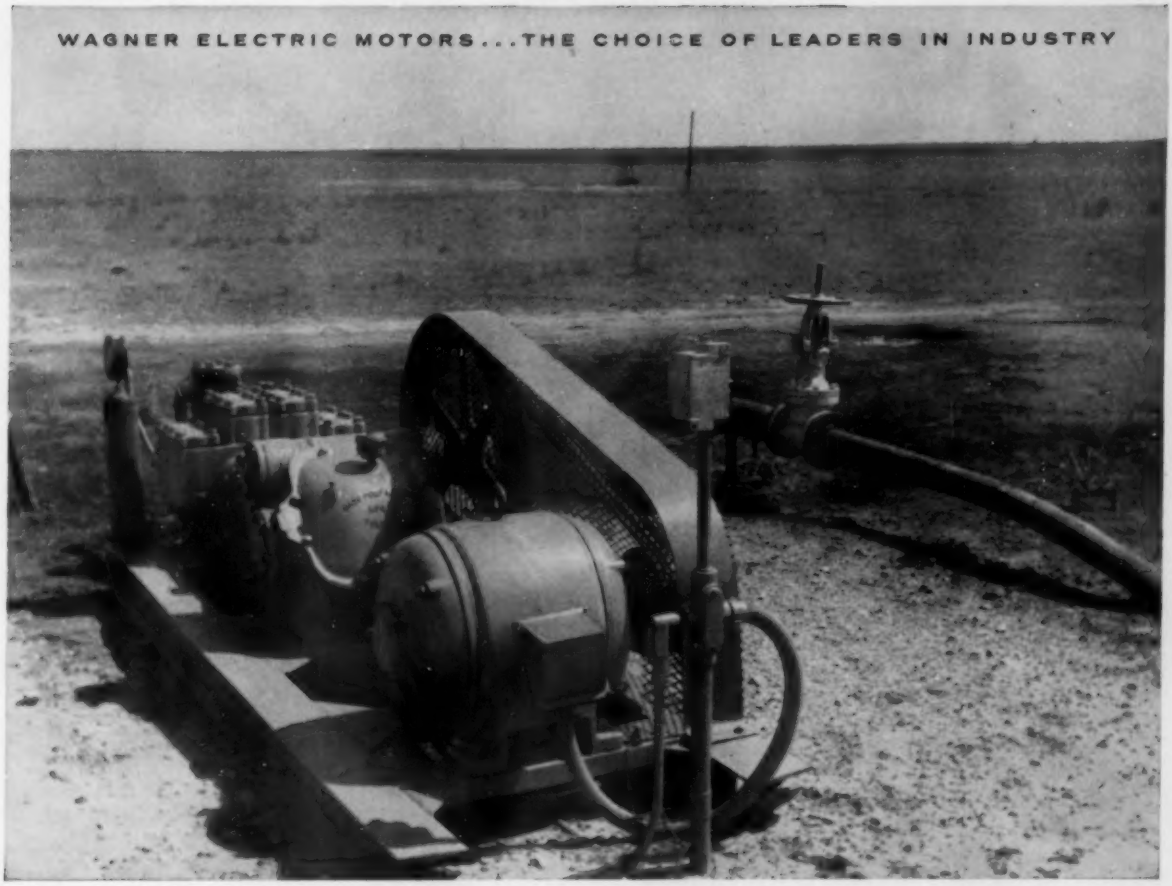
Oil Field Supply Stores
Everywhere

WAGNER ELECTRIC MOTORS...THE CHOICE OF LEADERS IN INDUSTRY



for uninterrupted gathering... power your pumps with Wagner Motors

A motor that drives a pipe line gathering pump has a downright lonesome job. Nothing for company but an occasional horned toad or rattlesnake. Even the visits of the maintenance crew are few and far between—especially if it's a Wagner Motor.

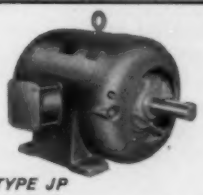
Wagner Type DP cast-iron frame oil well pumping motors are especially designed for year around, maintenance-free, rugged outdoor service. They are protected against rain, sand, snow, by an enclosure that is completely drip-proof—virtually splash-proof. They are protected against horned toads and rattlesnakes by screened ventilating openings. They are protected against acids, alkalies and corrosive elements by their cast iron frames and endplates. Conduit boxes are moisture-proof and dust tight.

For locations where only single-phase current is available, Wagner has high power factor type capacitor-start motors with the same protection. You can get Wagner oil well pumping motors *from stock* in your immediate area.

Wagner also supplies the petroleum industry with Type JP explosion-proof motors in ratings through 250 hp. Bulletins MU-132 and MU-137 give full information. Write for your file copies.

TIME-TESTED FAVORITES OF THE PETROLEUM INDUSTRY

TYPE DP



TYPE JP

In the field... *In the refinery!*

Wagner Electric Corporation
SERVING INDUSTRY SINCE 1891

M57-15

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

Wagner Electric Corporation
6389 Plymouth Ave., St. Louis 14, Mo., U.S.A.

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC

Why Lower-Groove Compression Rings Need Supplementary Pressure

Pedrick Formflex Seal-Cut Conformable Compression Ring

The force or pressure of the compression and combustion gases back of the rings is one of the most important factors in keeping the compression rings pressing against the cylinder walls for a satisfactory seal. The tension built into the ring contributes to this, but in a relatively minor way.

The top compression ring enjoys the greatest assist from combustion-chamber pressures. The gas pressure available to the second ring is only what passes through the top-ring gap, and is substantially less than cylinder pressure. The pressure behind the 3rd ring is still further reduced. Thus, by the time the gas pressures reach the lowest compression ring usually there is not sufficient force to enable the ring to maintain a seal, and it is here that it is most important to maintain a seal to prevent the gases from going further.

The ring used in the lowest compression groove needs special assistance to do its job. This is provided in the Pedrick FORMFLEX Seal-Cut compression ring. It is a single cast-iron ring of much less radial thickness for greater conformability and response to pressures. Its special-design of overlapping ends close the gap completely. Its big assistance comes from the Pedrick "Equalizer" which backs it up and provides adequate additional outward pressure to seal at the cylinder wall and stop blowby. This pressure is exerted everywhere around the ring and is absolutely uniform.

The result is a ring conformable enough to follow cylinder-wall irregularities and with enough pressure to maintain an effective seal. Power is preserved. Contamination of the lubrication oil from blowby gases is avoided. There is no build-up of undesirable and potentially-dangerous gas pressures in the crankcase.

Why not get the full benefit of Pedrick's experience in the design and application of conformable compression, as well as conformable oil rings, to your big diesel and natural-gas engines? For engineering details on the application of conformable compression rings, write for Form 434. WILKENING MANUFACTURING CO., Philadelphia 42, Pa. In Canada: Wilkening Manufacturing Co. (Canada) Ltd., Toronto 2.

Pedrick PISTON RINGS

PEDRICK PIONEERED *Conformable* RINGS FOR BIG-BORE ENGINES

They Say—

Texaco on octanes, Suez

"Last year . . . in order to raise by 1 point the octane rating of all Texaco gasoline, we were required to increase our annual operating costs nearly $7 million. To increase these ratings 1 additional point would cost over $10 million more per year. . .

"In working out a solution to the Suez problem, the free governments must establish a sound basis for future operations by making it clear that law, order, and principle are still fundamental to human relations and that faith in the observance of contracts is essential to the further development of international commerce."

Augustus C. Long, chairman of the board, The Texas Co., in a statement to company stockholders.

New Harris bill opposed

Dear Sir:

Both the I.P.A.A. board of directors and The Oil and Gas Journal have . . . reluctantly recommended support of the Harris-O'Hara gas bill on the theory that it may be the best we can get and and that it is better than nothing. This bill concedes to the federal Government the power to regulate the price and conditions of sale of gas by the producer, which is completely unprecedented in our system of free enterprise, and this was supposed to purchase the consent of the federal control advocates to elimination of the public utility type of rate determination based on cost of reserves.

The futility of such a course of appeasement was never more clearly demonstrated than when Charles H. Kendall, Office of Defense Mobilization general counsel, presented the Eisenhower administration's position on the bill. According to Kendall the administration approved of the concessions that had been made, but insisted the FPC should also have the right to consider cost of reserves in fixing prices to be received for gas by the producer—i.e., make public-utility type rate determinations.

It should be obvious now that this bill is not "better than nothing"; it's

Here is a new full-revolving, stationary-mounted crane — the UNIT Mariner — specially designed for off-shore drilling operations. Conceived, developed and perfected by UNIT, the Mariner meets all requirements for cargo handling from a fixed mounting as applied to ships, barges or off-shore platforms. Unlike conventional cranes, the Mariner emphasizes unusual strength in turntable, roller path, rollers, hook shoes, boom and hoist mechanism.

A special, heavy-duty "A" frame permits capacity loads with extended boom at long radius. The famous UNIT sealed cast gear case serves as a protection against salt spray.

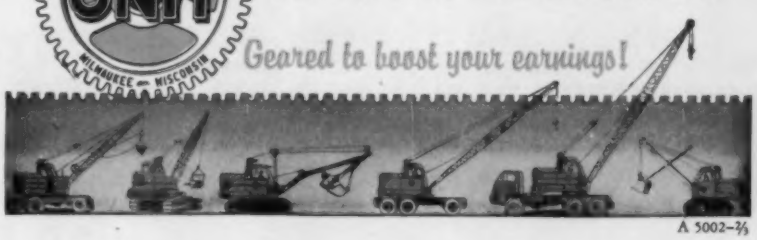
SAFETY is a major feature. Incorporated in the Mariner design, are positive and mechanical boom stops. These boom stops control the angle of elevation and prevent the boom from whipping back. Also the safety-promoting Full Vision Cab enables the operator to see what he is doing at all times. Load ratings are based on high factors of safety.

Yes, the Mariner is designed primarily for your type of cargo handling. Get the facts. Send for bulletin — NOW.

UNIT CRANE & SHOVEL CORP.
6327 W. Burnham St. • Milwaukee 14, Wis., U.S.A.

UNIT CRANE & SHOVEL CORP. UNIT MILWAUKEE — WISCONSIN

Geared to boost your earnings!



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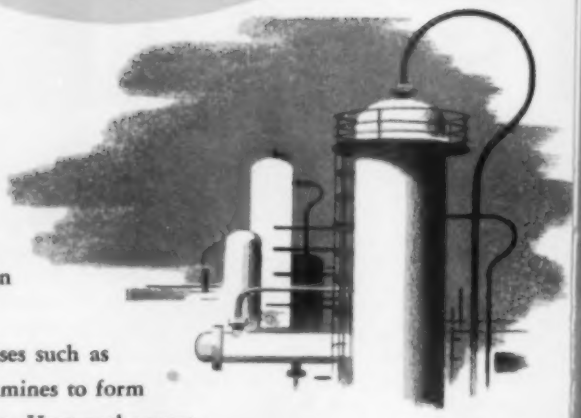


This amine gas treating process is adaptable to the removal and recovery of hydrogen sulfide from natural and refinery gases, for desulfurization and dehydration of natural gas, for purification of liquid hydrocarbons, and for separation of carbon dioxide from hydrogen and synthesis gases.

The process was developed upon the principle that acidic gases such as hydrogen sulfide and carbon dioxide react with certain amines to form compounds which may be broken down by heat. Heat exchangers, therefore, play an important role in the conservation of heat in the process.

The adaptability of Western's engineering, design and fabricating facilities to the varying requirements of different processes typifies the versatility and flexibility of Western's manufacture of efficient, economical heat transfer equipment.

Western heat exchangers are performing efficiently in many gas treating applications throughout the petroleum industry.

A Western representative can aid you today.

WESTERN

HEAT EXCHANGERS

WESTERN SUPPLY COMPANY

P.O. Box 1888 – Tulsa, Oklahoma

worse than nothing. Once the right to regulate price is conceded how can government control be restrained short of complete nationalization of the gas industry? The voluntary relinquishment of freedom of contract would not only be a compromise of our own principles but a betrayal of the trust of those who have stood with us in battling the encroachment of federal controls.

I urge that the industry oppose enactment of this legislation and that we unite in a determination to accept nothing less than complete victory in the fight for one of our fundamental rights.

Giles A. Penick, Jr.
Tulsa.

Canadian oil on U. S. market

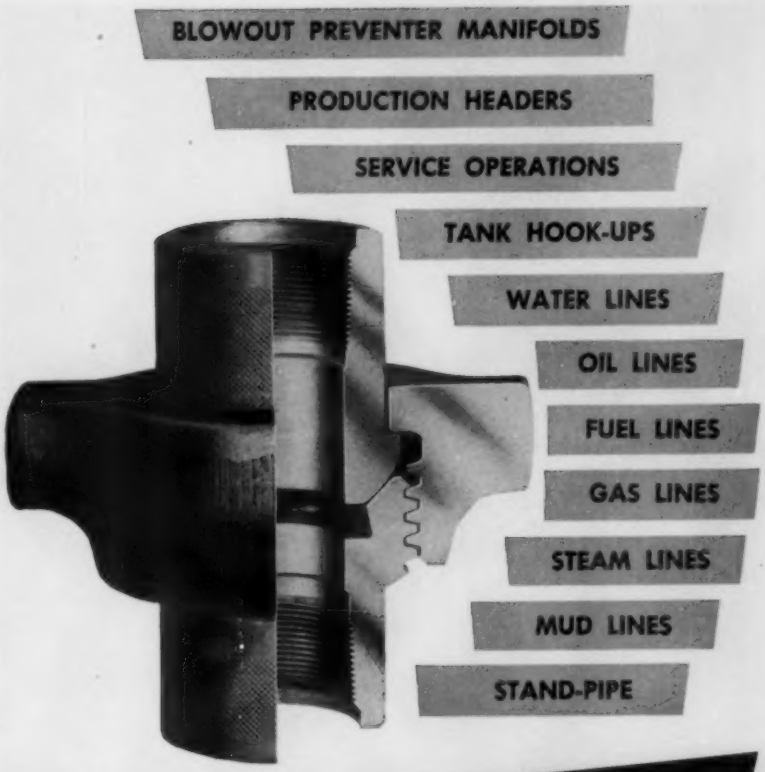
DEAR SIR:

JOURNAL ARTICLE "GRAY RULES IMPORTS EXCESSIVE" YOUR APRIL 29 EDITION REPORTS PLANNED OIL IMPORTS FROM CANADA FINAL HALF THIS YEAR AT 415,000 BBL. DAILY. AS CANADIAN I WOULD LIKE TO SEE THIS FIGURE REACHED BUT REGRET PIPELINE CAPACITIES WEST AND EAST FROM WESTERN CANADIAN FIELDS MAKE THIS IMPOSSIBLE. OUR INFORMATION . . . INDICATES MAXIMUM CANADIAN OIL EXPORTS FINAL HALF THIS YEAR 228,000 BBL. DAILY, MOSTLY TO UNITED STATES PLUS LIMITED VOLUME TO JAPAN.

THIS WOULD COMPRISE ABOUT 68,000 BBL. DAILY TO AMERICAN MIDWEST AND GREAT LAKES REFINERIES CONNECTED BY PIPELINE TO CANADIAN SOURCES, ABOUT 80,000 BBL. DAILY TO PUGET SOUND REFINERIES CONNECTED BY PIPELINE, AND UP TO 80,000 BBL. DAILY AVAILABLE FOR TANKER MOVEMENT TO CALIFORNIA AND LIMITED JAPAN SHIPMENTS.

OUR FORECASTS FIRST HALF 1957 INDICATE EXPORTS AVERAGING 182,000 BBL. DAILY ALL TO UNITED STATES INCLUDING ABOUT 67,000 BBL. MIDWEST AND GREAT LAKES AND 115,000 TO PUGET SOUND AND CALIFORNIA.

EXPORTS REPRESENT FULLY ONE-THIRD WESTERN CANADIAN FORECAST PRODUCTION, AND CONTINUED ACCESS TO AMERICAN MARKETS THUS VITAL TO CONTINUED GROWTH CANADIAN OIL RESERVES WHICH ARE VITAL NOT ONLY TO CANADA BUT TO OUR AMER-



YOU NAME THE JOB-
There's a WECO UNION to do it Better

• Wherever a union is required, you will find there's a Weco Union in the exact size and pressure to assure you positive leak-proof protection . . . provide fast make-up and break-out . . . last longer with less trouble . . . do an all around better job of sealing and service.

Ask for Weco Unions at your nearest supply store.

U-5-56

WELL EQUIPMENT MFG. CORP.
HOUSTON, TEXAS

WECO®

Division of CHIKSAN COMPANY *a subsidiary of* FOOD MACHINERY AND CHEMICAL CORPORATION

CHEMICAL
FEEDERS
for accurate metering of compounds
In the oil fields . . . on pipe lines . . . in your power house . . . wherever the metering of various liquids calls for accuracy, you'll find a Manzel. Adjustable from 0 to 1 gallon per minute. Experienced field engineers available for consultation.
Manzel
LUBRICATORS • CHEMICAL FEEDERS • SLURRY PUMPS
A Division of Houdaille Industries, Inc.

ICAN NEIGHBOR BOTH IN PEACETIME AND EMERGENCY. OUR EXPORTS TO UNITED STATES STARTED WITH AVERAGE 8,000 BBL. DAILY 1954, ROSE TO 51,000 BBL. DAILY 1955, 112,500 BBL. DAILY 1956. THE 1957 AVERAGE MAY BE 205,000 BBL. CONTINUED GROWTH NATURALLY VITAL IF CANADIAN INDUSTRY TO HAVE ADEQUATE INCENTIVE.

PRESENT AMERICAN CONSIDERATION OF FOREIGN OIL IMPORTS MUST TAKE INTO ACCOUNT THESE IMPORT FACTORS:

1. BROAD BASE OF AMERICAN INVESTMENT IN CANADIAN OIL INVOLVING MANY AMERICAN INDEPENDENTS ALONG WITH MAJORS.

2. ESTABLISHED CONNECTIONS BY PIPELINE BETWEEN CANADIAN FIELDS AND AMERICAN REFINERIES WHICH COULD NOT BE DISRUPTED WITHOUT CONSIDERABLE COST TO AMERICAN INDUSTRY AND CONSUMERS.

3. STRATEGIC POSITION ON NORTH AMERICAN CONTINENT OF CANADIAN FIELDS IN RELATION TO CONTINENT'S MARKETS.

4. CANADIAN EXPORTS ARE ALL TO AMERICAN MARKET AREAS DEFICIENT IN OWN PETROLEUM SUPPLIES. ALL THESE ARE SPECIAL CONDITIONS WHICH DO NOT APPLY TO OTHER FOREIGN SOURCES OF SUPPLY OF THE UNITED STATES AND SHOULD WEIGH HEAVILY IN ENSURING CONTINUED CLOSE CO-OPERATION BETWEEN OUR TWO NATIONS IN BUILDING UP FUEL RESOURCES OF THE CONTINENT FOR OUR MUTUAL PEACETIME AND SECURITY NEEDS.

CARL O. NICKLE, M. P.
PUBLISHER,
DAILY OIL BULLETIN
CALGARY

(Editor's note: The Journal's April 29 import figures were virtually doubled due to an error in calculation. The correct figures appeared on Page 76 of the May 6 issue.)

Schoeppel: Controls must go

"The example of local uses for the natural-gas reserves of the producing states is being repeated in dozens of locations throughout the Southwest in order that the producers may avoid the paralyzing hand of federal controls by being forced to sell their gas to interstate pipelines.

"The consumers of this country in

These tool joints have completed 22,000 feet of hole. Hard-faced with Coated Tube Stoodite, they still show little wear

TWO WELLS DRILLED...and more hole to go

In Bakersfield, California, where formations are sometimes only moderately abrasive, this string of 4½" drill pipe was used by a local oil company to drill two different wells. Manually hard-faced with Coated Tube Stoodite, welding procedure was entirely conventional. Deposit areas were first outlined with chalk; two guide beads of Coated Tube Stoodite were then run around the circumference to establish and maintain a uniform width of deposit. The area between these beads was finally filled in by a series of wash passes, using the same material.

The photo was taken after completing two 11,000-foot wells in the Bakersfield area. Very little wear is evident; the hard-facing has maintained both gauge and square shoulders... proof again that a nominal investment in Stoody hard-facing pays big dividends in increased equipment life and service.

NOTE: There is of course no substitute for Stoody Tube Borium on tool joints in highly abrasive formations where maximum wear resistance is required.

For detailed information on proven ways to reduce wear, Stoody offers two free books... "Oil Field Hard-Facing" and "Stoody Guidebook." Call your Stoody dealer for copies (see the "Yellow Pages" of your phone book) or write direct.

STOODY COMPANY
11938 East Slauson Avenue
Whittier, California

you can judge

the comparative values of furnace design as applied to operating requirements.

It's quite simple

there are **9** basic factors which must be evaluated to obtain the full comparison of values

1—Average radiant transfer rate. 2—Maximum deviation from average radiant transfer rate. 3—Average and maximum transfer rate in convection section. 4—Maximum tube wall temperature, radiant or convection. 5—Maximum efficiency with specified excess air. 6—Controlled thermal recirculation of flue gases to provide even heat distribution throughout full length of each tube and equalized heat distribution around each tube. 7—Overload and corresponding transfer load. 8—Design to provide: structural column supports · Ladders · Platforms · Tube Removal facilities, etc. 9—Degree of assembly; of the furnace structure and of the heating surface.

Whenever all these 9 specifications are applied to all the operating requirements, you can be sure PETROCHEM ISOFLOW FURNACES will be found most economically desirable.

No other furnace design can claim the recognition and acceptance achieved by PETROCHEM ISOFLOW FURNACES . . . starting with one installation in 1940, January '57 records more than 1650 ISOFLOW FURNACES in operation and under construction—a record that is incomparable just as all Petrochem Isoflow furnaces are more economically desirable by any comparison.

PETROCHEM-ISOFLOW FURNACES

UNLIMITED IN SIZE . . . CAPACITY . . . DUTY

PETRO-CHEM DEVELOPMENT CO., INC. • 122 EAST 42nd St., New York 17, N. Y.

REPRESENTATIVES:

Rowson & Co., Houston • Wm. H. Mason Co., Tulsa • Lester Oberholtz, Los Angeles • Parrillo-Lovally, Chicago • D. D. Foster, Pittsburgh • Turbex, Philadelphia • Flapp, Brackett & Durgin, Boston • G. M. Wallace & Co., Denver & Salt Lake City

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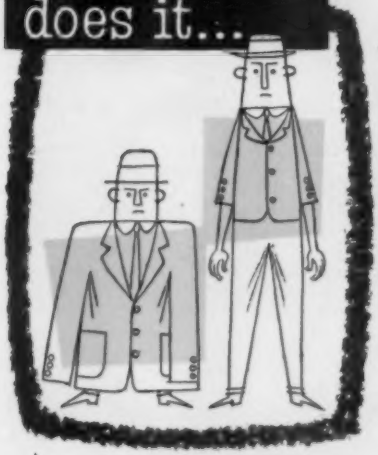
no one coat does it...



one source does

Valdura offers maintenance paints made from specific resins for every condition

EPON

VAL-CHEM. Versatile, chemical resistant metal primer for use under any finish coat. VALPON ENAMEL. Prevents damage by oils, solvents, alkalies and other chemicals on wood, metal or masonry.

PARLON

PARAVAL ENAMEL. Not affected by acids, alkalies and other chemicals. Used on wood, metal, concrete or masonry. RUBBER BASE ENAMEL. Combines excellent exterior durability with high chemical resistance.

BAKELITE

SUPER SERVICE ENAMEL. Resists chemical, moisture and abrasive conditions on metal wood or masonry. ASPHALT ALUMINUM PAINT. 98% waterproof metal coat prevents rust, rot, corrosion. Highest reflectivity.

COAL TAR

SEWAGE DISPOSAL BLACKS. Used for protecting concrete and metal surfaces from water, etc., found in sewage plants, reclamation projects, refrigeration systems, metal and concrete pipe, marine exposures.

URETHANE

URAVAL. The very latest type of coating that combines the ultimate in resistance to chemicals, solvents, marring and abrasion. Uraval will stand up where all other types of coating have failed.

ALKYD

M & F ENAMEL (General Maintenance), VALKOTE (Implement Enamel), DARYWHITE. Products that utilize the outstanding durability of alkyd resins. All these coatings are hard, tough, quick drying and color retentive.

Valdura maintenance paints are stocked by leading industrial distributors everywhere!

VALDURA PAINTS THAT ENDURE

VALDURA
HEAVY DUTY
PAINT DIVISION
AMERICAN-MARIETTA CO.
101 E. Ontario St., Chicago 11, Ill.
687 Wellington St., Ottawa, Canada

the nonproducing states should take serious and alarming note of this development, because I say to them frankly, unless federal controls are removed from this great industry they will most surely be faced with shortages of this convenient, clean fuel.

"The price will also be higher. Because shortages always mean higher prices . . . "

Sen. Andrew F. Schoeppel, (R-Kans.), in a speech at the formal dedication of Spivey Gasoline Plant, Attica, Kans.

CALENDAR OF EVENTS

MAY

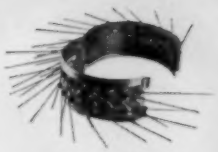
19-22	Texas Independent Producers and Royalty Owners Association, Galvez and Buccaneer Hotel, Galveston, Tex.
20-22	American Petroleum Institute, division of transportation, central committee on transportation by water and tanker corrosion symposium, San Francisco.
20-22	American Gas Association, chemical, engineering, and manufactured gas production conference, Balmoral Hotel, Bal Harbour, Fla.
20-23	American Society of Mechanical Engineers, twenty-ninth annual conference and exhibit of the oil and gas power division, Kentucky Hotel, Louisville, Ky.
21-23	Pennsylvania Gas Association, annual meeting, Pocono Manor Inn, Pocono Manor, Pa.
22-24	American Association of Oilwell Drilling Contractors, conference for drilling executives, Houston.
23-24	Kentucky Oil and Gas Association, annual membership meeting, Hotel Phoenix, Lexington, Ky.
23-24	American Institute of Mining, Metallurgical, and Petroleum Engineers, third annual joint meeting, Rocky Mountain petroleum sections, Northern Hotel, Billings, Mont.
23-24	Western Petroleum Refiners Association, southwest regional technical-industrial relations meeting, Hotel Paso del Norte, El Paso, Tex.
27-29	Rocky Mountain Oil and Gas Association, twelfth annual convention, Denver.
29-31	Annual short course in gas technology, Texas College of Arts and Industries, Kingsville, Tex.

JUNE

3-5	Petroleum Electric Power Association, annual convention, Amarillo, Tex.
3-7	Oil-Heat Institute of America, thirty-fifth annual convention, Sheraton-Plaza Hotel, Boston.
4-6	Second annual Appalachian Underground Corrosion Short Course, West Virginia University, Morgantown, W. Va.
6	Pennsylvania Grade Crude Oil Association, thirty-fourth annual meeting, Penn-Sheraton Hotel, Pittsburgh.
9-13	American Society of Mechanical Engi-

B and W Inc.

FOR A GOOD CEMENT JOB



B & W Hinged Nu-Coil Scratcher

B and W Rotating Scratcher — Multi-Flex Type

Movement of Casing...

. . . equipped with B and W Centralizers and Scratchers (reciprocating or rotating), until the plug "bumps," provides the highest percentage of successful cement jobs.

B and W Inc.

Well Completion Specialists

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Box 5266
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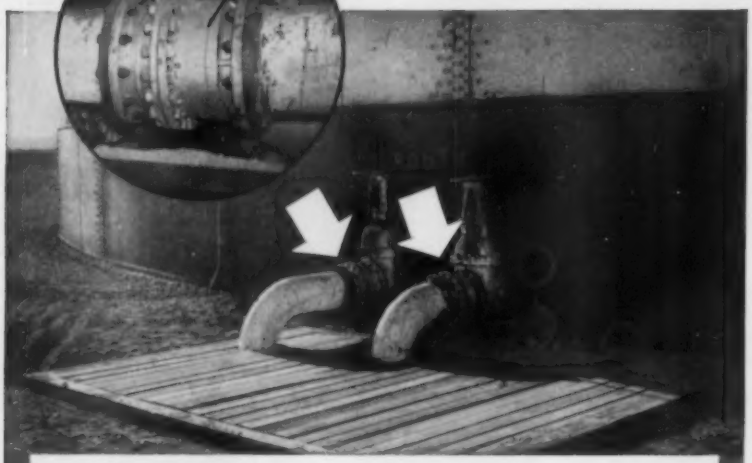
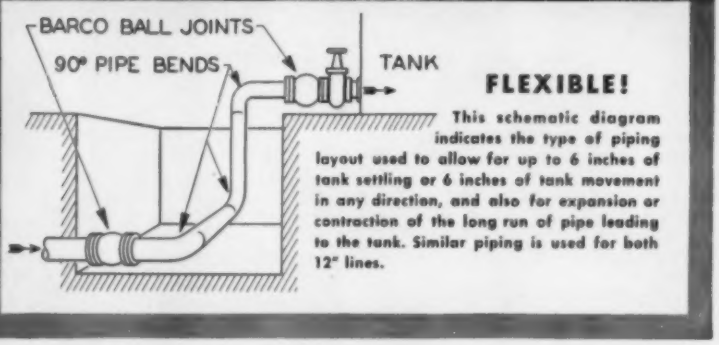
6928

NEW

12" BARCO
Flexible Ball Joints
(also new 8" and 10" sizes)





FLEXIBLE!

This schematic diagram indicates the type of piping layout used to allow for up to 6 inches of tank settling or 6 inches of tank movement in any direction, and also for expansion or contraction of the long run of pipe leading to the tank. Similar piping is used for both 12" lines.

Built to Handle Big Tank Jobs!

One of the first places where twelve of Barco's new large size Flexible Ball Joints have been put to use is on three 170,000 bbl. West Coast tanks which receive crude from a new 12,000 ft. long 24" off-shore pipeline. As shown in the above photograph, each tank is connected by two 12" lines—each fitted with two 12" Barco Ball Joints. The joints provide the following advantages:

1. **Allow for tank settling or tilting. Also pipe expansion.**
2. **Isolate tanks against earthquake shock; also pump shock.**
3. **Maximum protection against Fire Hazards.**

For detailed information about new 8", 10" and 12" Barco Ball Joints, see our nearest representative or WRITE FOR NEW CATALOG 215B. Joints available in Bar-Ductile metal or steel; flanged or welding ends. 15° angular flex.

FOUNDED 1908 BARCO PRODUCTS BACKED BY EXPERIENCE

BARCO MANUFACTURING CO.
539-F Hough Street • Barrington, Illinois

The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Revolving Joints
In Canada: The Holden Co., Ltd., Montreal

neers, semiannual meeting, Sheraton-Palace Hotel, San Francisco.

10-12 Interstate Oil Compact Commission, midyear meeting, Yellowstone National Park.

10-14 Gordon Research Conferences, petroleum, Colby Junior College, New London, N. H.

12-14 Engineering Institute of Canada, annual meeting, Banff, Alta.

16-21 American Society for Testing Materials, annual meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

17-21 Gordon Research Conferences, catalysis, Colby Junior College, New London, N. H.

18-19 Rocky Mountain Oil and Gas Association, annual meeting of refining committee, Northern Hotel, Billings, Mont.

19-21 Association for Computing Machinery, twelfth annual meeting, University of Houston, Houston.

20-21 Western Petroleum Refiners Association, Mid-Continent regional technical-industrial relations meeting, Broadview Hotel, Wichita.

20-22 National Oil Scouts and Landmen's Association, annual meeting, Hotel Cosmopolitan, Denver.

23-27 Canadian Gas Association, Jasper Park Lodge, Jasper, Alta.

JULY

8-19 Industrial Statistics for the Process Industries, second annual conference, sponsored by American Society for Quality Control and the University of Oklahoma, Lockett Hotel, Norman, Okla.

AUGUST

26-28 Seventeenth annual Appalachian Gas Measurement Short Course, West Virginia University, Morgantown, W. Va.

28-30 Instrument Society of America, International Symposium on gas chromatography, Kellogg Center, Michigan State University, East Lansing, Mich.

SEPTEMBER

3-5 Pacific Coast Gas Association convention, Fairmont and Mark Hopkins Hotels, San Francisco.

5-7 New Mexico Geological Society, eighth annual field conference, southwestern Colorado.

8-13 American Chemical Society, 132nd national meeting, New York City.

9-10 Independent Natural Gas Association of America, annual meeting, Shamrock Hilton Hotel, Houston.

11-13 National Petroleum Association, fifty-fifth annual meeting, Traymore Hotel, Atlantic City, N. J.

19-21 Rocky Mountain Oil Show, fairgrounds, Casper, Wyo.

25-25 American Society of Mechanical Engineers, petroleum mechanical engineering conference, Mayo Hotel, Tulsa.

26-27 Western Petroleum Refiners Association, Rocky Mountain regional technical-industrial relations meeting, Henning Hotel, Casper, Wyo.

26-27 Mid-Continent Oil and Gas Association, Louisiana-Arkansas division, Roosevelt Hotel, New Orleans.

30-Oct. 2 American Oil Chemists' Society, 1957 fall meeting, Netherland Plaza Hotel, Cincinnati.

THE *Joy 35* SHOT HOLE RIG... MOVING FAST

A shot hole rig has to get around . . . has to get in . . . get the hole down . . . and get out. That's the Joy "35". It's lightweight—extremely portable . . . mounted on a short wheelbase truck, it gets in anywhere. It gets hole down fast because it's the only rig of its size that has four speeds forward . . . gives you just the right speed for the formation being drilled to get the fastest penetration. And the Joy "35" stays on the job. The entire machine is built as a group of unit assemblies . . . each of which can be replaced or exchanged independently.

Find out more about the rig that is moving fast—the Joy "35" . . . write ***Joy Manufacturing Company, Oil Field Drill Division, P.O. Box 35326, Airlawn Station, Dallas 35, Texas.*** In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*

Get complete details on the Joy "35." Write for bulletin 152-31

WSW 06467-182

JOY... EQUIPMENT FOR OIL FIELDS

27 SALES & SERVICE LOCATIONS

Denver, Colo.; Salt Lake City, Utah; San Francisco and Los Angeles, Calif.; El Paso, Texas; Carlsbad, N.M.

Baash-Ross Tool Co. Div.—Abilene, Corpus Christi, Houston and Odessa, Texas; Harvey, New Iberia and Shreveport, La.; Ardmore and Oklahoma City, Okla.; Avenal, Bakersfield, Long Beach, Newhall, Taft, and Ventura, Calif.; Casper, Wyo.; Hobbs and Farmington, N.M.; Olney, Illinois.

Export Sales—Joy Manufacturing Company, 60 E. 56th St., New York, N. Y.

HERE'S HOW Welex dyna-jet* SAVES ME MONEY

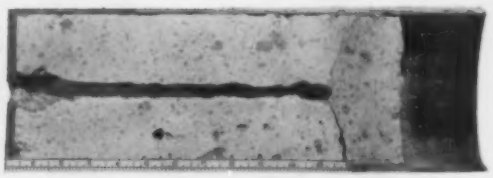
I

The Welex Dyna-Jet performance record since this new concept of perforating was introduced has proved itself a real money-saver to producers throughout the oil industry. Production data from every area shows an average

40% decrease in break-down pressures

This is more proof that the Welex Dyna-Jet is the greatest improvement in perforating since the introduction of the jet process by Welex more than 12 years ago.

II



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TULSA, OKLAHOMA

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JOURNALLY SPEAKING

Fuel of the Future

YOU'VE heard about this Project Vanguard—the plan to launch a series of earth satellites — man-made moons that will circle the globe at thousands of miles an hour and radio back information about interplanetary space, cosmic rays, solar radiation, and stuff like that.

Know what they're going to use for fuel? Kerosine. Plain, ordinary, old-fashioned kerosine. Cleaned up and purified a bit, maybe, but still kerosine. After all the talk about mysterious new fuels of the future for rocket ships and space travel, it comes as something of a shock to learn that the forward-looking, future-planning, free-dreaming Vanguarders are resorting to such a mundane fuel as kerosine to get their brain child off the ground.

Why, kerosine is the oldest man-made liquid fuel (unless you count whale oil, tallow, and the olive oil used by the vestal virgins). It was distilled from soft coal before there was any petroleum industry—and long before even Jules Verne dreamed of traveling to the moon.

But this doesn't necessarily give the oil industry an inside track in providing the fuels of the future. There's likely to be competition. We keep hearing veiled references to a lot of secret research and classified projects for developing "high-energy" fuels for guided missiles, rocket ships, and maybe space travel.

Lord knows how much the taxpayers are sweating to finance these attempts to displace petroleum as the fuel of the future. We hear tell of experiments with all kinds of chemicals and stuff as rocket propellants, including plastics and even rubber. (Hope that rubber fuel doesn't smell like the old overshoes our neighbor tossed in his trash burner.)

And we know of at least two factories under construction to produce a mysterious high-energy fuel by a secret process using boron as a principal raw material.

Of course several oil companies are now advertising that their gasoline contains boron. This may give them a foot in the door if boron is going to be the fuel of the future, but we suspect that at present these motor fuels are about 99 44/100 per cent pure gasoline.

Notice we said pure gasoline, not plain gasoline. Gasoline isn't plain any more. It's a mighty fancy compound, made by some of the most intricate processes known to chemical science.

If you're not already aware of this, skim through this issue and look at some of the papers presented last week at the A.P.I. midyear refining meeting and you'll get an idea of what a complicated job it is to make gasoline today. (Of course if you are a refiner you'll want to study these papers in detail and apply them in your plant.)

But these papers mainly deal with gasoline of the present. What if gasoline, after all, is the fuel of the future, and not boron, hydrogen peroxide, plastics, or old rubber boots? How will this gasoline of the future be made, and what will it cost?

Well, one of the papers in this issue suggests that by 1960 motor gasoline will be 110 octane, and tells how it may be made. It also says that this will increase the cost by more than 6 cents a gallon. That's an increase of about 50 per cent over the refinery cost of making today's gasoline.

And 1960 isn't very far in the future. What the fuel for 1980 will be or what it will cost is anybody's guess. All we know is that gasoline keeps getting better and better, and more and more of a high-energy fuel. In the future it may or may not meet the rocketeers' needs for space travel.

But we'll predict that at the rate research is progressing in the oil industry, petroleum products will give the boron, peroxide, etc., boys a good run for their money in developing the fuel of the future at a competitive cost.

—Henry D. Ralph.

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Why the price of gasoline is going up

MOTORISTS complain about the rising price of gasoline without giving proper consideration to the concurrent increase in its quality.

Certainly the price has gone up in recent years, but not as much as the increase in the fuel's performance in a modern automobile. These ratios may be reversed in the future. The price of gasoline will go up sharply in the next few years, and so will its quality. But the price is likely to increase faster than the quality.

Were it not for the quality increase, gasoline prices quite likely would be moving downward, due to technological improvements and mass production and distribution.

THE PRICE INCREASE is due entirely to the motorists' demands for high-performance cars. Detroit keeps turning out more powerful, higher-compression, more "critical" engines which require fuel of increasingly exacting specifications, most notably in octane rating.

What this means is just becoming apparent in dollars and cents. One major company reports it was required to increase its annual operating costs by $7,000,000 in order to raise the octane ratings of its gasolines by one point, and that raising the ratings one additional point would cost over $10,000,000 more per year. On that basis, the last increase of one octane number boosted the industry's operating costs by $100,000,000 per year.

If the present trend continues it is estimated that by 1960 high-performance cars will require 110-octane gasoline. Refinery engineers estimate that this will require investment in refining facilities 40 per cent above that required for today's gasoline. This 1960 gasoline will cost 6 cents per gallon more to make—about 50 per cent above the refinery cost today.

This projected price increase does not include any increases in the cost of crude oil, labor, steel, or other costs that may occur in the next few years. It is simply the cost of improving gasoline quality to keep pace with the public's desire for perfection in car performance.

How long will this performance race continue? Will motorists pay the cost of luxury driving? Will the automotive designers price the gasoline makers out of business?

Last week a top atomic scientist predicted that long before petroleum resources are exhausted the price of gasoline will make private cars too expensive for the average person to operate.

THIS CAN'T HAPPEN. Both auto and oil companies would prevent it by developing economy cars and fuels. But until the present trend is reversed, gasoline prices will climb sharply. So will consumer complaints.

The least that refiners can do is to warn motorists that the price increases are coming—and explain why. The customer is king. If he wants increasingly luxurious private transportation he will have to pay for it in higher-priced cars and higher-priced fuel.

Good Wells Make Good News

May 20, 1957

RIVERFRAC*, an exciting new concept in hydraulic fracturing, is finding widespread use in many oil and gas producing areas. Large volumes of fresh water or unsaturated salt water are pumped into the producing zone at a high injection rate. Many authorities think salt removal is an important reason why Riverfrac is successful in some cases where other fracturing treatments have failed. Here are some results of Riverfrac.

- **Ward County, West Texas** (Old Well): This well, completed in the Yates at 3000 feet, had declined from 10 bopd to 1 bopd in about 18 months. Riverfrac, using 22,000 gallons of fresh water and 10,000 pounds of sand, removed 18,920 pounds of salt. Average injection rate was 34 bpm. *90 days after fracturing, well tested 115 bopd.*

- **Washington County, Illinois** (New Well): This well was completed in the Trenton Lime 4290-4400 feet open hole. Initial test was show of oil. Riverfrac was used. Fluid was 67,000 gallons fresh water with addition agents to control silicate swelling and emulsions. 55,000 pounds of sand was used. Fracturing was accomplished at average injection rates of 40 bpm. Although only 3600 pounds of salt was recovered, *well tested 95 bopd after treatment.*

- **Kay County, Oklahoma** (New Well): Completed in the Mississippian Chat 4154-4180, tested 6 bopd before treatment. Well was treated with Riverfrac, using 20,000 gallons of water with 20,000 pounds of sand at 37 bpm. *70 days following treatment, production tested 65 bopd with 40 bwpd.*

- **San Juan County, New Mexico** (New Well): Completed in Point Lookout Sandstone. Depth, 4805-5034 with four sets of perforations totaling 117 feet. Riverfrac was used. 256,196 gallons fresh water and 180,000 pounds sand were injected in four stages at 59-78 bpm. 160 rubber-coated nylon ball-sealers were used in one stage. Initial production: 30,000 cfpd. After treatment, well tested 7,400,000 cfpd. through ¾-inch choke at 506 psi. *Production was increased 247 times!*

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The Top Twenty in U. S. Oil

Company	Total Assets	Gross Income	Net Income	Crude-Oil Production	Runs to Stills
	(Thousands of dollars)			(bbl. per day)	
Standard Oil Co. (N. J.)	$7,901,530	$7,126,855	$808,535	2,020,000	2,449,000
Gulf Oil Corp.	2,872,270	2,339,715	282,658	962,889	667,806
Socony Mobil Oil Co.	2,819,619	2,750,300	249,504	675,288	858,957
The Texas Co.	2,504,130	2,046,305	302,263	970,345	975,874
Standard Oil Co. (Ind.)	2,425,233	1,890,228	149,432	294,855	642,343
Standard Oil Co. of California	2,041,373	1,452,521	267,891	754,120	753,162
Sinclair Oil Corp.	1,473,269	1,180,102	91,071	166,528	437,319
Phillips Petroleum Co.	1,372,832	1,033,391	95,203	207,558	244,765
Shell Oil Co.	1,315,235	1,635,435	135,848	304,000	498,000
Cities Service Co.	1,197,863	973,715	62,152	120,937	258,030
Atlantic Refining Co.	700,130	544,865	47,157	109,226	205,782
Tidewater Oil Co.	679,563	522,556	37,990	100,538	178,724
Union Oil Co.	650,705	396,425	34,241	103,082	168,000
Sun Oil Co.	578,357	731,412	56,160	122,233	259,749
Continental Oil Co.	548,920	576,278	51,817	154,395	140,974
Sunray Mid-Continent Oil Co.	504,101	332,668	45,310	82,790	106,129
Pure Oil Co.	488,315	486,185	36,560	67,088	151,659
Ohio Oil Co.	365,777	274,953	41,216	108,355	42,421
Skelly Oil Co.	339,084	251,392	34,093	71,497	46,258
Standard Oil Co. (Ohio)	332,632	392,526	26,592	36,813	140,125

Gulf Second Biggest in Oil—Maybe

A PERTINENT oil question today is, "Who's on second?"

Standard Oil Co. (N. J.) tops all other U. S. oil companies by a large margin in assets, gross income, net income, production, marketing, and runs to stills. But second place is something else. Here's the situation:

Gulf Oil Co. is second in total assets with $2,872,270,371.

Socony Mobil Oil Co., Inc., is second in gross income with $2,750,299,937.

The Texas Co. is second in net income with $302,262,620.

Assets are generally accepted as the best measure of size. In this respect there was quite a shift among the top 20 U. S. companies in the past year. Two of them, Gulf and Tidewater Oil Co., moved up a couple of notches.

Jersey continued to rank well out in front in all categories. It has more, produces more, and sells more than any two of the other companies. Its total assets were just a shade less than those of the next three companies combined. Financial information for Jersey Standard and the other companies is from Carl H. Pforzheimer & Co. The operating figures are from annual reports.

Changing pattern . . . Gulf moved into second place by adding almost as much to its total assets in 1956 as Jersey. In doing so it moved up from fourth and went ahead of both Socony Mobil and Standard Oil Co. (Ind.). Gulf added $711,449,351 in assets last year. Jersey added $737,425,150.

Texaco also moved up a notch, going from fifth to fourth. It added $389,454,002 to its total assets. Indiana Standard fell back to fifth, the most pronounced drop.

The biggest switch, however, was further down the line. It was Tidewater's climb from fifteenth to twelfth. Its addition of $194,198,000 to total assets was, proportionately, the biggest of all. Much of this was accounted for by the new Delaware City, Del., refinery.

In making its big jump, Tidewater moved ahead of Union Oil Co. of California, Sun Oil Co., and Continental Oil Co.

Other changes saw Phillips Petroleum Co. and Shell Oil Co. switch places, with Phillips moving from ninth to eighth. Skelly Oil Co. and Standard Oil Co. (Ohio) also traded, with Skelly moving into nineteenth

and Sohio dropping back to twentieth.

The first 10 companies, which were shuffled considerably in standings, made up the entire billion-dollar-plus category.

It's unlikely that any other company will break into the select group very soon. Eleventh-ranked Atlantic Refining Co. is closest to the mark with $700,129,959. And during the past 2 years it has added less than $100,000,000.

While Gulf displaced Socony Mobil in assets, Socony retained second place in gross income. Gulf was third in this grouping and Texaco fourth. Both Gulf and Texaco exceeded the $2-billion income mark for the first time.

Despite its ranking of fourteenth in total assets, Sun rated eleventh on a gross-income basis, topping Atlantic, Tidewater, and Union Oil, all of which had greater assets.

Sun was also one of the four companies among the first 20 with gross incomes in excess of total assets. Shell, Continental, and Standard of Ohio were the others.

Net income . . . Jersey's net income, as did its total assets and gross income, came close to equalling that of the next three companies. Jersey netted $808,534,919. The next three had a combined net of $852,910,508.

Biggest proportionate gains in net income were made by Socony and Atlantic, both up 20 per cent from the year before. Phillips, Ohio Oil Co., and Tidewater made almost the same both years. The only company to drop more than 1 per cent was Indiana Standard, down about 5 per cent. Indiana Standard's decline, however, followed a big jump the year before.

Companies with the biggest earnings were those with extensive foreign holdings, large importers, and those with crude supplies in excess of refinery runs.

Foreign operators benefit from two factors, low-cost crude and a rapidly expanding market. Demand outside the United States is growing at twice the rate of domestic demand. This also makes foreign markets less competitive.

California Standard, well out in front in net compared to gross income, has ample production outside the United States and is a large importer. Texaco, with the industry's second highest net, is also in this category. So is Gulf, which had a better-than-average net for the group.

Companies in the lowest ratio of net-to-gross income produced only enough oil to meet 25 to 50 per cent of their requirements.

IT'S PRODUCER VS. PIPELINER as Elton Hyder, Jr., right, quizzes Texas Pipe Line Co. president J. W. Emison in Austin when . . .

Pipeline Fight Reopens

Texas oil common carriers give their story: Producers really want a market for their crude and not transport

AUSTIN.—Common carriers of crude in Texas now are telling their story in a dispute with producers over the growing number of state wells unable to get pipeline connections.

Testimony of the pipeline spokesmen marked the second round of a battle before the Texas Railroad Commission. It resumed here last week in the Stephen F. Austin Hotel after a 40-day recess.

The pipeliners claim that producers actually want a market for their crude rather than transport. They added that pipelines would extend gathering systems if the producer has a buyer for the oil.

In the first round April 1-3, five associations of Texas producers paraded witnesses before the commission. They attempted to show that the lines and the common purchasers of Texas crude are throttling inland Texas production in order to fill growing domestic demand with imports *(The Oil and Gas Journal, April 8, page 63).*

Elton Hyder, Jr., Fort Worth attorney, was spokesman for the producers at those hearings. He pointed out that nine major oil companies own all of the common-carrier lines out of West, West Central, and North Texas. He said these same firms are all common purchasers of crude in Texas, and seven of the nine rank among the 12 largest importers of oil into the U. S.

The majors, he charged are deliberately holding down trunk capacity and extensions of gathering systems. They are refusing to buy new oil so as to bring into the country more of their own cheap foreign oil.

As proof, he furnished exhibits showing that:

. . . More than 8,000 wells now are unable to obtain pipeline connections —more than 6,000 of them in fields where other wells are connected. Twenty years ago, he argued, there were no unconnected wells in the state. The wells then produced essentially the same on the average as now and were just as scattered if not more so. The change in status, he declared, is due to skyrocketing imports during that period.

. . . Oil trucking is up 637 per cent since 1948. Producers are losing needed money thereby in evaporation and other losses due to trucking and in high-cost truck transport rates.

. . . Gathering mileage is lagging. The increase in gathering line mileage from 1936-55 was 206 per cent, while

number of wells was up 233 per cent, production 257 per cent, and reserves 233 per cent.

Hyder said the named major firms are violating Texas laws by refusing connections and failing to expand gathering and trunk facilities.

He asked the commission to order common carrier lines to connect immediately all unconnected wells in Texas and to expand trunk and gathering facilities as needed to do this.

In the alternative, he said, the common purchasers should be ordered to pay all gathering costs in case "the true owners of our common carriers prefer the continuation of trucking facilities."

Hyder cited laws under which he said the commission has the power to do either of these things.

He spoke for the Texas Independent Producers and Royalty Owners Association, the West Central Texas Oil and Gas Association, the North Texas Oil and Gas Association, the East Texas Oil Association, and the Panhandle Producers and Royalty Owners Association.

Pipelines take turn . . . The pipelines got their turn at bat last week.

The lines offered no single spokesman. Rather, attorneys and top officials for each common carrier spoke solely for that firm.

Testimony was lengthy. And equally lengthy cross-examination by Hyder for the producers stretched out the hearings through May 15.

Basic pipeline defense was testimony showing that:

. . . Producers want market, not transport. Top pipeline brass pointed out that common-carrier lines, like railroads, ship for anyone but do not buy what they ship. Leadoff witnesses for Texas Pipe Line Co., Service Pipe Line Co., and Sinclair Pipe Line Co. claimed never to have denied trunk line space to a producer who had a market for his oil.

. . . Pipelines extend gathering systems if the producer has a buyer for his oil and if the new system would pay out with a reasonable profit within a reasonable length of time. Testimony showed desired profit to be 6½ to 7 per cent and desired payout to be between 3 and 10 years. Pipeline officials claimed no gathering system is denied if these qualifications are met.

The carriers also presented evidence to show that they are continuously connecting new wells, expanding gathering systems and trunk capacity as needed.

Exhibits too were filed to show that the parent firms of the carriers are not benefiting from favoritism as to new connections.

J. W. Emison, president of Texas Pipe Line, testified that his firm gathers oil from 2,386 leases in North Texas. Only 100 of these, he said, are owned by The Texas Co., largest stockholder in the carrier. Emison said Texas Pipe Line connected 522 new leases in 1955 and 1956 of which only four were owned by Texaco.

Emison added that Texas Pipe Line's trunk capacity is sufficiently large that it has never had to prorate its connections.

Other pipeline witnesses followed the same defense pattern in the 3-day marathon. Witnesses were: R. J. Andress, executive vice president of Service Pipe Line Co.; G. M. Johnson, vice president of Sinclair Pipe Line Co.; Gayle G. Billings, manager of West Texas operations for Shell Pipe Line Corp.; S. G. Kershner, vice president and general manager of Texas-New Mexico Pipe Line Co.; O. Q. Lomax, president of Humble Pipe Line Co.; L. H. True, president of Magnolia Pipe Line Co.; J. L. Irvin, vice president of West Texas Gulf Pipe Line Co. and general manager of the domestic pipelines of Gulf Refining Co.; E. H. Foster, Phillips Pipe Line Co., and C. W. Gracey, supervising accountant for Atlantic Pipe Line Co.

Billings testified concerning operations of the Shell-operated Rancho Pipe Line systems as well as the company's wholly owned West Texas Trunk.

Parents get involved . . . All pipeline witnesses were quizzed hard in cross-examination by Hyder as to their relations with their stock-owning parents.

Hyder attempted to show that carriers are refusing to connect new wells because the majors who buy don't want the oil, allegedly since they want to import instead.

Hyder drew admissions from most of the carrier executives that the lines could stop paying dividends to their owners, expand lines, and make connections to all wells in their respective areas if their parent firms ordered them to do so.

He also drew admissions that all of each carrier's stock was voted at board meetings by an executive of the carrier's major-company parent.

The matter will drag out over a long period of time before the Railroad Commission acts.

Commissioner Ernest O. Thompson said that after pipeline testimony is completed, producers will be given 30 days in which to file briefs. The pipeline companies then will have 30 days in which to reply. After this the commission will study the transcript and then hear arguments.

——— *Industry* briefs

Richfield Oil Corp. has asked the Corps of Engineers for a permit to build a 2,618-ft. causeway from shore to its artificial island under construction on a 1,175-acre lease off Rincon, Calif. The causeway would be built in a southwesterly direction from Punta Gorda. The island is being built in 45-ft. of water. Completion is slated early next year.

The Navy's oil reserve, all of it in Elk Hills, is estimated at 670,000,000 bbl. by Albert S. Miller, director of naval petroleum reserves. Miller said the Navy could produce 175,000 to 200,000 bbl. daily if needed for national defense. Output is now 16,000 bbl. daily. This nets about $1 million a month over expenses.

Phillips Petroleum Co. and the Federal Power Commission differed sharply last week on how much Phillips lost on its interstate gas sales in 1954. The company claims its deficit was $35.2 million. The FPC says it was $2.5 million, based on a 9 per cent rate of return.

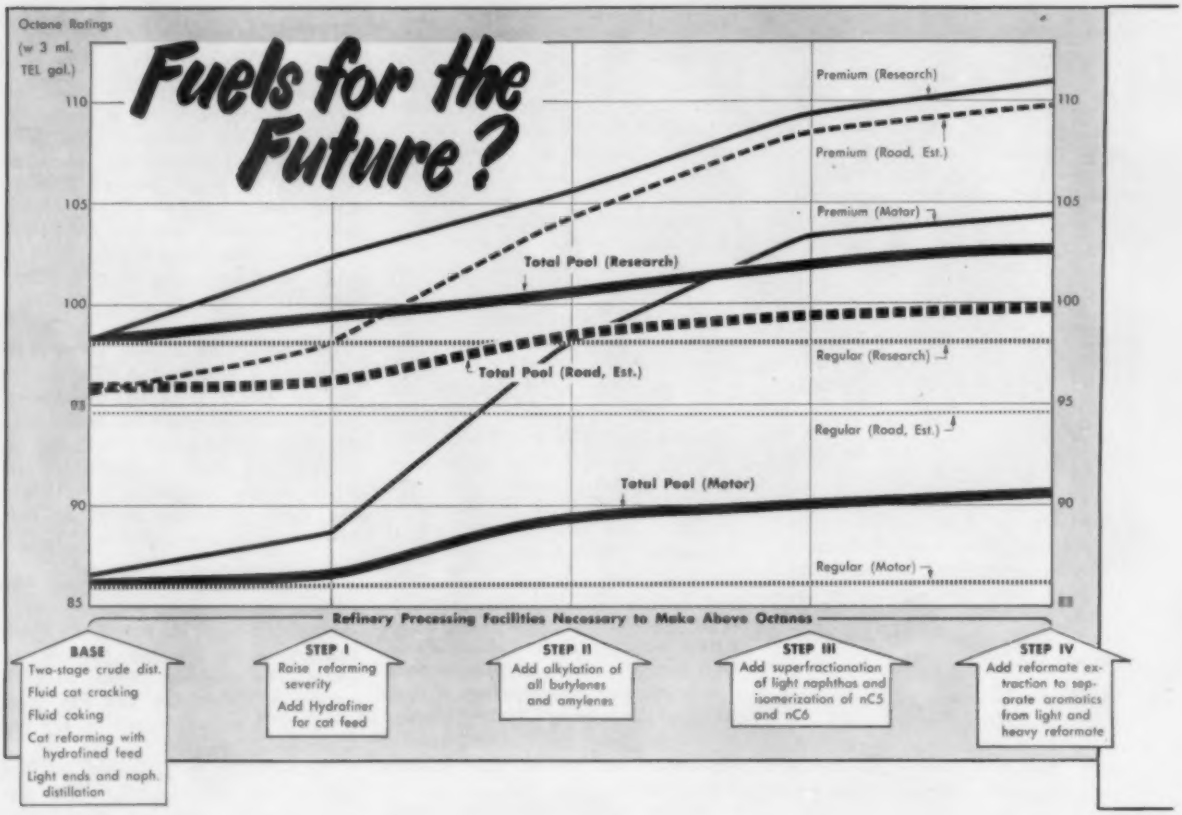
To back up its argument, Phillips said it lost $37.7 million last year on interstate sales which involved $84.9 million in service costs. The company is seeking rate increases which would bring field prices ranging up to 25 cents per 1,000 cu. ft. The Phillips rate case was the basis of the Supreme Court ruling in 1954 which made gas producers subject to federal price control.

California Oil Co., of Perth Amboy, N. J., is coming out with a superpremium gasoline called Calso Supreme 300-Plus, which it says will meet engine horsepower requirements in the 300-plus range. Price will be about a cent a gallon higher than the company's displaced premium. The company will continue to use its ethylene dibromide additive and will add a new detergent-action additive.

The Interior Department last week wrote finis to the crisis created last November by the closing of the Suez Canal.

Sec. Fred A. Seaton released, with thanks, 12 industry men who enlisted as consultants without pay to help the department with the problems of the European oil lift.

That operation "has been highly successful even though transportation through the Suez Canal has not been resumed," Seaton wrote the consultants.



How to Find Road Octanes in the Lab

George Weber
Refining Editor

PHILADELPHIA.—This year may well chalk up a record rise in octane ratings of premium-grade gasoline. With many companies introducing stepped-up premium grades, or super third grades, many brands rating 99 and 100 octane are now available over much of the nation.

But these are research ratings. What counts with the motorist is the road octane rating, which indicates just how well his car utilizes antiknock quality in everyday driving. Road octane ratings are determined by extensive road testing. But this is costly and time-consuming.

Methods for anticipating the road octane of today's and tomorrow's motor fuel by using the relatively simpler laboratory tests for research and motor ratings were presented to the industry last week at the annual midyear meeting of the American Petroleum Institute's Division of Refining.

Two comprehensive papers outlining two methods were prepared by engineers and research teams of Ethyl Corp., Detroit, and of the Petroleum Laboratory, E. I. du Pont de Nemours & Co., Inc., Wilmington.

The Ethyl method . . . At low engine speeds, research and motor ratings alone can do a good job of defining octane numbers, according to T. W. Warren, H. A. Toulmin, J. B. Retzloff, and C. A. Hall of Ethyl Corp.

But at higher speeds, which will probably continue as a critical factor, gasoline composition must be considered. Olefin concentration tends to depress road octanes at high engine speeds.

Since Detroit is likely to design future cars for high engine speeds, refiners should maximize aromatic and paraffinic content of future fuels to moderate road depreciation of research octane ratings. But olefins, which give the lowest cost per R.O.N., will continue to be effective in satisfying the engine at low speeds.

Ethyl reports that highly aromatic fuels of average boiling range need not worry refiners from the standpoint of deposit trouble, at least for the present. While some high compression ratio cars may cause considerable deposit problems, such conditions will probably be corrected by further advances in combustion-chamber design, better lubricating oils, and use of gasoline additives.

These conclusions were drawn from data accumulated in an extensive road-testing program.

Ethyl selected three high-compression engines, modified to 11:1, which were considered representative of types to be used in the future. More than 100 commercial-type gasolines, including a wide variety of hydrocarbon-type compositions, were road rated in the three vehicles. The same fuels were laboratory-rated by the research and motor methods.

From the great volume of data obtained at varying engine speeds, Ethyl derived the formula:

$$\text{Road Octane Number} = A + B(\text{R.O.N.}) + C(\text{M.O.N.}) + D(\%\ \text{olefins})$$

The four cofficients necessary for rating fuel at higher engine speeds were determined for the three cars tested. While the coefficients varied with engines, their use in the formula provide good correlation.

The Du Pont method . . . The results

Refinery, octane studies give clues to gasoline of the future

THIS is a hypothetical projection of what future gasolines may look like, from the standpoint of octane ratings. It may well point the way for refining developments over the next several years. This picture was presented to refiners at last week's midyear meeting of the A.P.I. Division of Refining.

Represented here is the hypothetical gasoline production in an inland refinery charging sour West Texas crude. As new processing facilities are added, operations are adjusted to give a fixed gasoline-pool yield, split 40/60 into premium and regular. All benefits from new quality improvement are plowed into premium grade.

There is no chronological base for this chart. But the ultimate premium gasoline of 110.8 research octane number premium should satisfy cars with 12:1 ratios.

The basis for this chart is taken from a paper presented at the fuels session by Humble Oil & Refining Co. Research and motor octane ratings of both grades and of the total gasoline pool came from this paper.

The remainder of the session was concerned with devices for approximating the road octane ratings of future fuels. Two approaches to this important problem were presented, one by Ethyl Corp. and the other by Du Pont Co. Both represented extensive road-testing programs.

Computed road octane ratings of the fuels plotted above, from correlations provided in the Ethyl and Du Pont studies, show fair, but not precise agreement. This is to be expected since such correlations are presented as supplementary to actual road testing. They cannot be expected to give highly accurate results by themselves.

The two companies used different cars in their test fleets, and cars show varying road octane ratings on identical fuels. Ethyl used the Modified Borderline procedure for determining road octanes. Du Pont used the Modified Uniontown method.

The estimated road octane ratings plotted here represent an average of the results calculated for high engine speed, assuming the same olefin content for fuels used in both tests. The greatest discrepancy on any calculations varied 2.7 road octanes, while most of the spreads amounted to less than 2 numbers.

This is progress in the effort to obtain estimated road ratings of future fuels without the need for extensive road testing. The tools now available to refiners can be of great aid in projecting their gasoline blends to obtain the most road octane for the money.

Refiners can also take heart from the improvement in road ratings with relation to research octanes in these hypothetical future fuels. As added paraffins in the form of alkylate and isomers bolster the rising aromatic content, the research octane depreciation in actual use may be expected to moderate.

But these octanes will cost money. How much of this added cost can be offset by greater engine efficiency is up to Detroit. The petroleum industry has the know-how to put out premium-grade fuel capable of satisfying 12:1 compression ratio engines. Making these fuels work for the benefit of the motorist is a joint responsibility of the oil and automotive industries. G.W.

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of a program involving over 5,000 road-octane measurements in four 11:1 and 12:1 engines, using 73 blends of 28 possible future-fuel compounds, were reported by J. J. Greytak, J. S. Bellah, and W. E. Morris of Du Pont.

Road ratings obtained by the Modified Uniontown method correlated well with the average of the research and motor ratings, they found. This correlation, they reported, was not improved by including such factors as hydrocarbon types or physical properties.

Prediction of high-speed ratings was improved, however, by including a factor representing olefin or aromatic concentration. At high speeds, road ratings are reduced by about 1 octane number for each 10 per cent olefins present. They can also be predicted by adding about 1 number for each 20 per cent aromatics present to motor-octane ratings.

Their tests indicated that deposit troubles in the future will be much the same as those encountered today. Hence, refiners may expect that future fuels will probably not increase the prevalence of surface ignition.

In rating individual fuel components, Du Pont found that catalytic reformates had higher road octane numbers than catalytically cracked stocks of the same research number. Even higher road octane ratings were chalked up by 2,3-dimethyl butane, light alkylate, and isopentane.

They found that light butane-butylene alkylates from different processes, showing varying R.O.N., have essentially the same road blending octane numbers. Total product from the isomerization of pentane-hexane feed stocks will not be used in raising the road octane ratings of base fuels above the 100-octane level. The same is true of polymer gasoline, and catalytically cracked naphthas.

Hence, Du Pont foresees that catalytic reforming, alkylation, and isomerization will loom more important in making tomorrow's high road octane number gasolines.

Fuels of the future . . . The special-fuels section was rounded out by a refiner's view of fuels of the future, presented by S. P. Blumberg of Humble Oil & Refining Co. (see page 137).

According to Blumberg, processes now developed can be used to produce premium gasoline of better than 110 research octane number on a 40/60 volumetric split with 98-R.O.N. regular grade. While this is possible technically, the cost is high.

Blumberg's figures are derived from a hypothetical 50,000-bbl. inland refinery processing sour West Texas crude (see drawing). This basic refinery includes two-stage crude distillation, fluid catalytic cracking, fluid coking, regenerative naphtha catalytic reforming with hydrodesulfurization of feed stock, and propylene polymerization. It can make a 98.2 R.O.N. gasoline pool. It costs $920 per barrel of charge capacity to build.

By steps would come hydrogen treating for cat cracker feed, higher reforming severity, alkylation, superfractionation of light virgin naphtha, isomerization of normal pentane and hexane concentrations, and, finally, extraction of cat reformate. Adding these facilities would raise total plant investment to $1,280 per barrel.

Improving premium R.O.N. from 98 to 110.8 while maintaining a 40/60 ratio with a constant 98-R.O.N. regular grade would cost 6.1 cents per gallon. This is equivalent to 19.9 cents per research octane-number barrel.

Blumberg noted that sensitivity, or the difference between research and motor ratings, rises with higher reforming severity, but declines appreciably when alkylate and isomers are blended to gasoline stocks.

This bears out others' predictions that road octane of future gasolines will suffer until the percentage of branched-chain paraffins rises.

Firm Faces Bankruptcy

● Examiner tells Colorado Interstate to lower rates $15 million a year, refund $33 million; company claims collapse certain if order stands, seeks emergency funds

COLORADO SPRINGS.—Colorado Interstate Gas Co., with assets exceeding $130 million, says it faces bankruptcy under rates ordered recently by a Federal Power Commission examiner.

W. E. Mueller, president of the company, announced he would try to arrange short-term financing to tide the company over until the full commission can review Examiner Samuel Binder's decision, which was handed down May 8.

Binder disallowed most of two proposed rate increases on grounds the company is not entitled to "commodity value" or a "fair field price" for its own produced gas. The ruling was based on the U. S. Court of Appeals decision ordering the commission, in the Panhandle Eastern Pipe Line Co. case, not to rely solely on commodity value in arriving at the just and reasonable rate *(The Oil and Gas Journal, December 26, 1955, page 125, and May 21, 1956, page 217)*.

"If this decision is allowed to stand, there is no question in my mind but that the company will be bankrupted and placed in receivership," Mueller said. " . . . If this financing cannot be accomplished, our expansion program for the Rocky Mountain area will immediately shut down."

The decision . . . Binder ruled that gas customers supplied by Colorado Interstate are entitled to refunds totaling about $33 million dating back to 1954, and to a $15-million-a-year reduction in current rates.

The firm has been collecting rate increases, subject to refund, since January 1, 1954. It applied for a new rate increase, to be effective July 1. Binder ruled that only $13,500,000 of the $46,700,000 in added rates charged since 1954 is justified. He ordered new rates filed which would amount to about $4½ million a year over rates set by the FPC in 1952.

Colorado Interstate, he said, failed to show that it needed more than the amount reached by use of the traditional rate-base method to provide just and reasonable rates. He concluded that a 6 per cent return, rather than 6½ per cent, would be "fair and reasonable." But Colorado Interstate insists that the new rates would not permit a 6 per cent return because of costs incurred since the case started.

The effect . . . If the new rates ordered by the examiner had been in effect last year, Mueller said, his company wouldn't have earned any dividend on the common or preferred stock. It would not even have paid off the interest on bonded indebtedness.

"Binder's rates would have given us a net operating income for 1956 of $1,168,192," the president told stockholders. "Our interest requirement for debt for that year was $1,988,747. Under his figures, we would show a loss of 49 cents per share of common stock for the year.

"The same is true of the first 3 months of 1957. The examiner's rates, applied to our gas sales volumes, would give us a net operating income of $440,752 for that period. For the same 3 months our interest requirements are $580,906."

Mueller said that nothing less than a radical revision of the entire decision is necessary if Colorado Interstate is to maintain gas service.

The company last year had earnings of $9,381,445 on operating revenues of $46,818,982, and sales of 225,357,005,000 cu. ft.

The expansion which Mueller says is jeopardized would raise the company's valuation to $206 million. The major project would be a 345-mile, 30-in. line from Kit Carson, Colo., to Beatrice, Neb., to deliver 460 million cubic feet per day to Natural Gas Pipeline Co. of America for the Chicago market.

The issue . . . Whether FPC uses a cost or commodity-value method in determining the price of its own produced gas is particularly important to Colorado Interstate, which produced 62 per cent of its requirements in the year ended August 31, 1955.

The FPC originally upheld the commodity-value price proposed by Panhandle Eastern, another pipeline producer. But the Circuit Court remanded the case to the FPC. It declared that while the FPC doesn't have to follow the cost method strictly, it must use it as a starting point. The commodity (fair field) or any other approach may be used. But the end result must be a price that is just and reasonable and not more than sufficient to provide an incentive to produce gas. The Supreme Court affirmed the ruling when it refused a review.

Panhandle Eastern argued that there was no workable relation between the different rate-fixing methods. And it recently announced a cutback in drilling for gas because the price uncertainty made drilling for oil a better business venture.

The Harris-O'Hara bill now before Congress would fix rates at the "reasonable market price." Commodity value and several other factors would be considered by FPC in arriving at this figure.

Officers Ousted

Bentsen new president of American Tidelands

HOUSTON.—A group of Houstonians grabbed control of American Tidelands, Inc., last week and immediately announced plans for expanding operations.

Lloyd M. Bentsen, Jr., Houston attorney and former congressman, was named president to succeed Thomas Jordan. New management took over following a show-down between opposing stockholder groups. Bentsen and Frank Crerie, Houston investment broker, headed the fight against former management.

After being named president, Bentsen announced that negotiations are under way for financing a new offshore drilling barge. He said a committee also has been named to study feasibility of extending the company's operation to Venezuela.

American Tidelands, with headquarters in New Orleans, has one drilling barge operating in the Gulf of Mexico. This vessel, now drilling for The Texas Co., overturned off the Louisiana coast in the spring of 1955 after completing its first well *(The Oil and Gas Journal, June 27, 1955, page 69)*. American Tidelands has a $1,100,000 insurance claim pending as a result of the accident. Bentsen said he expects an early settlement of the claim.

In the proxy fight for control of the company, Crerie charged that the firm had "missed the boat" because of what he termed "unprogressive management." Crerie was one of the first underwriters of the company.

J. F. Corley, Houston independent oil operator and president of Marine Drilling Co., was named executive

vice president in the reorganization.

New directors include Robert G. Rice, Houston, former executive vice president of Tennessee Gas Transmission Co.; William S. Wallace, Houston, former overseas oil operator; Alfred McLean, Dallas attorney; and Walter Carroll, New Orleans attorney.

New Line Planned

Buckeye to build products line for Michigan markets

NEW YORK.—Buckeye Pipe Line Co. will build a 70-mile, 8-in. common-carrier products pipeline from Wayne, near Detroit, to the vicinity of Durand, Mich.

The line will cost $2 million. Buckeye said pipe has been ordered and the line should be completed early next year. The project will give Detroit and Toledo refiners pipeline transportation to the Lansing, Saginaw, Flint, and Owosso area market. Potential shippers would be Gulf Oil Corp., Pure Oil Co., Standard Oil Co. (Ohio), Sun Oil Co., Aurora Gasoline Co., and Socony Mobil Oil Co., Inc.

Another phase of Buckeye's products-system expansion will be completed this summer. Sheehan Pipe Line Construction Co. is handling the conversion of Buckeye's 116-mile, 8-in. crude line from Huntington, Ind., to Griffith, Ind. The conversion will provide Ohio refiners with an 18,000-bbl. daily outlet to the Chicago market. Sheehan should complete the takeup, reconditioning, and relaying by August 1.

Conversion of 32 miles of 8-in. crude line to products between Mantua, Ohio, and Youngstown, Ohio, is scheduled for completion this fall.

Cemetery to Be Leased

WASHINGTON.—Two sections of land in the Natchez (Miss.) National Cemetery have been transferred to the Interior Department for oil development to prevent drainage.

The land was turned over by the Army after the Geological Survey found the lands are within the known geologic structure of a producing field. The underlying oil is being drained by commercial development outside the reservation. The Bureau of Land Management will ask for lease offers shortly.

No drilling or other operations will be allowed on the reservation. Development will have to be through slant drilling from outside the cemetery. The Army will retain primary jurisdiction of the area.

watching WASHINGTON

. . . with Bertram F. Linz

O'Mahoney still sounding off . . .

ANY voluntary agreement to limit oil imports is likely to run into trouble in Congress, the administration has been warned.

Sen. Joseph B. O'Mahoney of Wyoming doesn't believe such a plan can be worked out now any better than over the past 2 years of effort. But he has warned ODM Director Gordon Gray that, even if made, it wouldn't be lawful. And it wouldn't be lawful even if directed by the President, he says.

Any plan under which competing companies unite in an agreed-upon course of action would have to have antitrust immunity to be legal, O'Mahoney explains. There is nothing in the Defense Production Act giving the attorney general authority to make such a grant, he says.

Eisenhower said he will consider whether voluntary action will meet the requirements of Section 7 of the Trade Agreements Act. O'Mahoney says he can't handle the problem that way. That law requires the President to take action. He cannot delegate that power to the importing companies.

O'Mahoney's own plan for dealing with imports calls for both quotas and high tariffs. Quotas would keep imports down. Tariffs would produce revenue the Government does not now receive from foreign oil. And that really is what the senator is aiming at.

Pipelines in the spotlight . . .

OIL pipelines, both here and abroad, are again getting a lot of attention in Washington.

Mobilizer Gordon Gray is talking with the American Pipe Line Corp. about government backing for a Gulf-East Coast products line. Texas Eastern Transmission Corp., meanwhile, is racing to get FPC approval for conversion of its Little Inch line to products. The result, Texas Eastern says, would be lower prices for gasoline.

The long-talked Texas-West Coast crude line has been given the blessing of the Justice Department. Independent competition is needed on the coast, antitrust chief Victor R. Hansen says. But he warns the department will not stand for absorption of an "undue amount" of the new supply by the major companies the Government is now suing.

A new Middle East pipeline running from the Persian Gulf to a Mediterranean outlet in Turkey is felt by the State Department to be "necessary." Such a line would be a guard against another Suez Canal closing.

As a final touch, the House judiciary committee will soon start an inquiry into the way pipeline companies have complied with a 1941 consent decree. The probe will be aimed at finding out what the companies have done. But it could also include a study of recent developments in pipelines.

Fishing at Alexandria . . .

THE Alexandria, Va., grand jury probe of the oil industry in being played in a fishbowl. As a result the Justice Department is getting a lot of uncomfortable attention.

After 2 months of work there is still no indication that the jury has been given any road signs to follow. The Government's call for documents covers the waterfront. They include even personnel lists and company telephone directories. That is hardly a sign that the probe is getting anywhere.

The companies involved in the inquiry are now openly calling it a fishing expedition. Esso Standard said just that in a motion in the federal court. Telephone directories aren't relevant to anything the jury is studying, the company charged. The call for them indicates that the Government is engaged in "the type of fishing expedition so often condemned by the court," it said.

100 LAWYERS representing most of the nation's gas interests have a field day.

Drawn-Out Gas-Market Battle Assured

- Final FPC ruling won't come before next year in scrap over who'll get big slice of upper Midwest market
- Examiner trying to clear away minor issues first; this means T.G.T.-Midwestern evidence won't come for months

WASHINGTON.—Final decision in the battle royal over the right to provide natural-gas service to a large section of the upper Midwest will not come before next year.

This became clear last week as the Federal Power Commission resumed its study of Midwestern Gas Transmission Co.'s big project *(The Oil and Gas Journal, May 13, page 75)*.

The second stage in the marathon hearings — they started in February 1956 — is expected to run until next winter, with a recess over August. Experienced pipeline-company lawyers predict it will be October before they set down to the basic issue.

The presence of more than 100 lawyers at the hearings last week showed the widespread interest in the case. They represent about 75 per cent of the natural-gas interests of the country, running from Canada to the Mexican border and from New England to California.

The hearings are being conducted by FPC Examiner Francis L. Hall. His first efforts are being aimed at disposing of the less important of the issues in the 20 dockets involving nine companies which make up the case.

Last week Hall heard the case of El Paso Natural Gas Co. and the Permian Basin Pipeline Co.; Iron Ranges Natural Gas Co.; and Northern Natural Gas Co.

El Paso, which carries gas from the Permian basin to Northern Natural's line at Amarillo, Tex., is seeking additional supplies. Northern Natural is opposing invasion of its northwestern markets by Midwestern and has countered with a plan to extend its system further into Minnesota and into North Dakota. Iron Ranges has applied for a distribution line north of Duluth and seeks to obtain gas from either Northern Natural or the proposed Midwestern line.

Both Hall and the lawyers for the various parties are trying to speed up the hearings. But more than 75 witnesses presented last year by Midwestern are yet to be crossexamined. And there are 88 intervenors who will be heard from time to time as the several companies present their cases. The intervenors include utility companies, municipalities, pipelines, state regulatory bodies, and other interests.

Hall's schedules call for the taking of all direct testimony before any witnesses are called for crossexamination. Pipeline lawyers said, however, that the nature of the issues is so complex that the crucial evidence, from Tennessee Gas Transmission Co. and Midwestern, which is associated with it, is not likely to be presented for several months.

The big issue in the case is whether Midwestern shall be allowed to build a system from which companies around the area to be served would meet "fringe" competition. But the question of imported gas, on which the northern half of the Midwestern project would depend, has become an issue in Congress.

Import bill offered . . . A bill which would practically bar the import of Canadian gas was offered last week by Rep. John P. Saylor of Pennsylvania. Present laws provide for FPC approval of imports unless they "will not be consistent with the public interest." Saylor's bill would hold it not to be in the public interest to export or import gas if it "will result in economic dislocation, unemployment, or injury to competing fuel industries of the United States."

"I am convinced that the FPC needs a legislative mandate from Congress to consider such other factors as the potential damage to the economy of the United States, including losses to the coal and railroad industries, unemployment, and over-all effect on the national defense (in passing on imports)," Saylor told the House.

New "Brain" Working

Tidewater's happy with its complex information system on the crude unit at its new Delaware City refinery

PHILADELPHIA. — Tidewater Oil Co.'s complex, new crude-unit information system is doing an excellent job.

The system is one of 13 in Tidewater's new Delaware City refinery. The crude-unit system has now had 8 months' experience in digital-indicating and trend-recording operations and 5 months' experience in logging and scanning.

The vote of confidence in the new and complex instrument system was voiced at a Division of Refining session here last week by James McDonald, of the Delaware City plant staff.

Loggers and scanners are being installed on other units in the new refinery. And, as a result of experience gained on the crude-unit system, they are being worked into the operating pattern quite rapidly. All of the refinery's 13 systems are expected to be in full use by July.

Scope of system . . . The heart of each information system is a combination data logger and continuous scanner.

The system logs all desired variables once each hour and makes the results available in the form of an automatically typed record, McDonald said.

The scanner is in operation continuously, monitoring five variables per second. When an off-normal point is detected, an alarm sounds and the variable is either indicated continuously or is recorded continuously on a trend recorder.

An additional feature of the system enables an operator to check any variable at will. Miniature recorders and controllers make the installation compact and efficient.

The system also provides integrated data on shift and daily rates of flow, averaged daily information on temperatures, and average figures on pressures and flows.

The company's accounting department uses integrated flow information on charges and yields. The other summary information is used by management and supervisory personnel to make operating decisions, McDonald said.

Equipment requirements . . . Included in the 13 complete information systems are 12 scanners, 18 typewriters, 18 digital indicators, 10 information consoles, and 15 trend recorders, all installed in 9 control rooms. Here are some other aspects of the systems:

Total point capacity	4,590
Points logged	1,935
Points blind-scanned	995
Points integrated or averaged and logged for accounting	786
Flow points	321
Pressure points	261
Temperature points	791

In each installation the information console is placed at the focal point of the control room. This unit contains the digital indicators, typewriters, and auxiliary alarms, and is backed up by the trend recorder.

Each system contains a standard tape puncher, McDonald said. Any item which can be logged can also be placed on the punched tape. In operation, however, only the accounting information will be taped.

Tank farm . . . The tank-farm information system makes use of remote gaging and temperature indication. These are shown on digital indicators, in hundredths of a foot and degrees, respectively. A computer is used in combination with the logger in this system.

For each of the 88 tanks, tank number, stock, and A.P.I. gravity group are pre-set into the system. Temperature and volume in each tank (corrected to 60° F.) are then determined and logged quickly and automatically, McDonald said.

CO_2 Blanket Cuts Explosions

PHILADELPHIA. — Explosions resulting from pumping kerosine are very much on the industry's mind these days.

Despite the advances in safe handling of petroleum fractions, there is still a lot to be learned about hazards involved in loading kerosine. Recent explosions and fires during pumping to tankers, barges, and storage tanks point up the problem.

But something is being done about it. Members of the A.P.I. Refining Division heard an interim report last week on a research project which is whittling away at the problem.

The U. S. Bureau of Mines and Cities Service Research & Development are carrying on the program jointly. The gist of their findings to date: Carbon dioxide blanketing helps reduce the hazard.

There were two ways to approach the problem of making combustible material safe—eliminate oxygen or the ignition source.

The ignition source — static electricty—presents an extremely tough problem today. Too little is known about the generation, accumulation, and discharge of static electricity when kerosine is pumped.

So M. G. Zabetakis of the Bureau of Mines and B. H. Rosen of Cities Service have directed their work at one phase of the problem. They attacked it from the standpoint of better understanding the role of the combustible and oxygen in gas-explosion phenomena.

This led to some new studies in the combustible properties of kerosine vapor, mist and foam in air, and in air diluted with carbon dioxide, nitrogen, and flue gas.

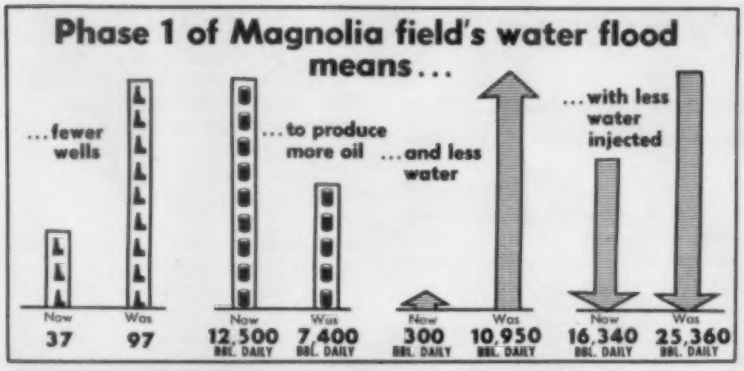
Fire hazards . . . Zabetakis and Rosen conclude from their work to date that the main hazards in handling kerosine at temperatures below its flash point arise from the formation of mists and foams in the vapor space above the liquid surface.

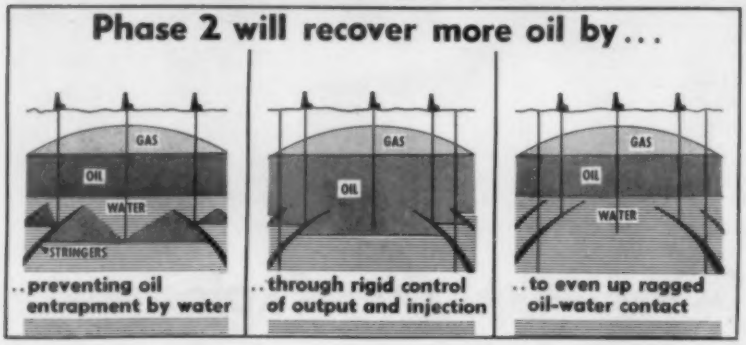
In pumping kerosine into an enclosed space, the extent of this mist and foam is quite limited. Thus, the use of an inert-gas blanket will prevent flame propagation in the presence of an ignition source.

Results of the study favored carbon dioxide over flue gas or nitrogen. In tests conducted aboard a T-2 tanker, an effective carbon dioxide blanket was formed during the major part of the loading operation by putting 300 lb. of crushed ice in the center tank and in each of the two wing tanks several hours before loading.

This decreased the oxygen concentration in the vapor space to a value below that required for flame propagation.

More tests are now planned under the same conditions in a 1,000-cu.-ft. cubical test chamber. Peak pressures and pressure rise will be investigated to learn more about the potential explosion hazards of kerosine mists and foams in various inert gas-air atmospheres.





Flood Starts Big Payoff

● Ultimate recovery will be more than doubled, but it won't come easy. While many headaches have already been whipped, the touchiest job of all is just coming up

MAGNOLIA, Ark.—"Phase 2" of one of the world's most intensively engineered water floods is under way in Arkansas' prolific Magnolia field.

This is the final part of a program which will net Magnolia operators an extra 31,000,000 bbl. of oil. It climaxes more than 5 years of solid, painstaking engineering work.

The payoff will be an estimated 60 per cent recovery of the oil in place—despite some really tough production problems.

Magnolia is a 19-year-old Smackover limestone pool 5 miles east of here. Although not unusually large, the 4,000-acre anticlinal feature has already produced about 85,000,000 bbl. of oil. Operators hope to more than double the ultimate recovery through the present two-phase secondary-recovery program.

Obstacles led to a simple cooperative water-injection operation in 1945, followed by unitization and the present comprehensive flood in April 1956.

Magnolia's prime problems were:

... **Dropping pressure.** The field's weak water drive, even when supplemented with injection of 12,500 bbl. of water daily under cooperative plan, still wasn't enough to hold pressure steady or build it up.

... **Expanding gas cap.** It was expanding into the oil zone threatening loss of otherwise recoverable oil.

... **Ragged oil-water contact.** Water was encroaching from high on the flanks faster than in the lower porous intervals of the pool.

Impermeable wedges and stringers extending up and in from the bottom of the pay have caused wide variations in the depth of the water-oil contact especially along the flanks. Water moving up faster through the most permeable and porous sections threatens to bypass and trap large volumes of oil.

The Magnolia unit, headed by Atlantic Refining Co. as operator, is carrying out a program designed to whip all these headaches and others.

The unit hopes to maintain the pressure, prevent expansion or shrinking of the gas cap, and—the most formidable task—even up the erratic water-oil contact.

The project probably has no peer so far as precise control of reservoir performance and of field contacts is concerned. The phenomenal engineering effort is described in the May 21, 1956, issue of the Journal, page 126.

Phase 1 . . . As operator, Atlantic is carrying out the unit conservation plan in two major steps. The first, which simply capitalizes on the efficiency of unit operation, has already been completed.

It involves shutting in the inefficient heavy water and gas producers, and completing and injecting through some of the new input wells. The results are spectacular.

The number of producing wells has been cut from 97 to only 37. Output has climbed to 12,500 bbl. daily from 7,400 bbl. daily. Water production is down to a negligible 300 bbl. daily from 10,950 bbl. This is only 2 per cent of total fluids produced. Before unitization water output was 60 per cent of total fluids produced. And the average gas-oil ratio has been slashed from 1,100:1 to the present 756:1.

All this has been accomplished with less water injected and with a much smaller operating force. Daily water input rate has dropped off to 16,340 bbl. from a high of 25,360 bbl. Atlantic is producing the field's 12,500-bbl.-daily output with essentially the same field production staff it used before unitization, when production was only 2,000 bbl. daily.

Phase 2 . . . Now comes "Phase 2," the job of straightening out the errant water-oil contact.

To do this, water must be injected in just the right places and in exacting volumes. Producing wells in a large number of cases must be recompleted at carefully calculated locations and depths. Producing rates of individual wells must be controlled.

The big part of this terrific task—the planning of where and how much—is finished. All that remains is to put the plan in action and make adjustments where needed.

The unit already has completed 5 of the 15 new input wells involved. These, mostly on the flanks, will help balance water movement into the oil zone, found at 7,500 ft., and stymie any trapping of oil by overriding water.

At the same time, the unit is recompleting 15 producers at intervals picked to complement this flank injection. Producing wells in locations where the oil-water contact is too low will be produced hard to help pull the contact up.

Worth the cost . . . All of this, of course, is costly. Atlantic already has spent more than $150,000. The initial investment to get the new project into full operation will cost about $1,000,000.

If engineering time of the planners were figured in, the tab would be much higher. And more money likely will have to be spent later.

Some of it is going into the search for a better source of injection water. Water now is coming from the shallow Sparta sand. Several salt-water zones have been partially tested, but none has yet proved adequate.

On the other side of the ledger is the saving in operating overhead from the unit's much smaller labor force. And the extra 31,000,000 bbl. of resulting oil will do considerably more than take care of the program expense.

More than 40 companies and individuals have working interests in the unit. The bulk—about 70 per cent—is owned by Atlantic, Carter Oil Co., Shell Oil Co., and the Vaughn interests.

Smog Secrets Lift

Cars and incinerators are culprits, new study shows

PHILADELPHIA.—The smog isn't clearing yet in some urban areas, but the mystery surrounding its formation is beginning to let in some daylight.

Evidence is building up that the culprits are automobiles and trash burners rather than petroleum refineries. One contributor to this evidence is "Silent Sam," a new mobile smog sampler and analyzer.

This second long-path infrared absorption cell was mounted in a trailer and moved in for a first-hand examination of the Los Angeles area's famous smog. The object: To double check laboratory studies of simulated smog and to verify the existence of "Compound X."

The results were reported by the Franklin Institute last week at the A.P.I. Division of Refining meeting here. The study showed there is a direct and specific relationship between exhaust gases from automobiles and air pollution.

The mystery compound which serves as an intermediate component in smog formation is peroxyacyl nitrate. It forms rapidly under certain conditions and is effective in concentrations as lean as five parts in 100 million.

Processing briefs

The first commercial hexane isomerization unit to be announced will be built at the Shreveport refinery of Atlas Processing Co.

The Penex unit, which is licensed by Universal Oil Products Co., Inc., will have a feed capacity of about 3,000 bbl. daily. It is designed to make 98 research octane number products.

Several other Penex units to process pentane and hexane feeds are in design or under construction. The Atlas unit, however, is the first to be identified. Details of the unit were revealed last week at the A.P.I. Division of Refining meeting in Philadelphia.

The American Petroleum Institute has Volume 2 of "Waste Gases and Particulate Matter" ready for distribution. This is the fifth edition.

Construction of Dow Chemical Co.'s petrochemical plant at Bay City, Mich., is scheduled to get under way early next year. The plant will consist of three units: cracking, ethylene, and butadiene. It will process petroleum derivatives from the adjacent plant of the Bay Refining Corp., which Dow acquired last year. The principal product will be ethylene.

Richard S. McClurg, currently staff assistant to General Manager W. M. Schuette of Dow's Midland division, has been named project manager.

Anlin Co. of New Jersey will build a 33-ton daily sulfur-recovery plant at Perth Amboy. Construction will be started within a month by Gencon, Inc., of Houston. Location is adjacent to California Oil Co.'s 83,000-bbl. refinery.

Calco will supply Anlin with about 7,000,000 cu. ft. daily of refinery gas rich in hydrogen sulfide. Anlin will strip H_2S for conversion to elemental sulfur and return the remaining hydrocarbons to Calco for refinery fuel. The recovery plant will be conventional. Completion is scheduled by the end of this year.

Carbide Chemicals Co., a division of Union Carbide Canada, Ltd., has gone on stream with its complete, integrated petrochemical plant at Montreal East. The $25-million installation converts refinery gases to polyethylene, ethylene oxide, ethylene glycol, ethanolamines, glycol ethers, and polyglycols. Construction began 2 years ago. Various units have been placed on stream in the past year. Now under construction is a $4-million addition to the polyethylene plant.

California Research Corp. has put a Cary Model 81 Raman spectrophotometer to use at its analytical laboratories at Richmond. The optical-electronic tool is used to give rapid and accurate identification of hydrocarbon molecules. It will be particularly useful in analyzing high-octane gasoline, lubricating-oil fractions, and petrochemical products. Built by Applied Physics Corp. of Pasadena, the new instrument has cut the time required for analyzing some fractions from 6 hours to 10 or 15 minutes.

Also for Refiners . . .

Two new laboratory methods for determining road octanes have been presented to A.P.I. Division of Refining midyear meeting in Philadelphia (P. 112) . . . Tidewater reports its complex crude-unit information system is working well at the Delaware City refinery . . . A carbon dioxide blanket will cut down chances for explosion resulting from pumping kerosine into an enclosed area (P. 117) . . . Autos and incinerators—and not refineries—are the chief culprits in the Los Angeles smog problem (P. 119) . . . Refiners honor John Newton, former A.P.I. vice president (P. 121) . . . Union Oil has started up operations at its experimental shale-oil retort near Grand Valley, Colo. (P. 122) . . . A pattern of 6 per cent wage increases is being set for the oil industry. Many companies are making that offer and O.C.A.W. says it will accept (P. 124) . . . Two East Coast investors have completed all details for building a 55,000-bbl. refinery in Panama (P. 131).

PLUS THESE TECHNICAL FEATURES: Isomerization gives high road antiknock properties while adding octanes (P. 132) . . . Research octanes to hit 110 by 1960 (P. 137) . . . Upgraded C_5 and C_6 paraffins to take more than 20 per cent of motor-fuel pool by 1960 (P. 142) . . . Esso's 2 years of automatic data logging (P. 147) . . . Pentane dehydrogenation more flexible, gives higher octanes than isomerization (P. 150) . . . Cutting corrosion in a crude unit (P. 157) . . . Two-year progress report on regenerative platinum-catalyst reforming (P. 168) . . . How 31 companies fight corrosion (P. 180) . . . Questions on Technology (P. 201).

Gas-Bill Hopes Fade

It may not get out of committee, and even if it does it faces a tough floor fight; it won't reach Ike this year

WASHINGTON. — Chances of the Harris-O'Hara gas bill reaching the President for signing this year have dwindled to the vanishing point.

Producer resistance to changes demanded by the administration was compounded last week by the opposition of consumers to any easing whatever of federal controls.

The bill now is in a tight spot. That is generally agreed, in and out of Congress. House Speaker Sam Rayburn of Texas went so far as to charge that the administration, willfully or not, may be killing the bill. At best, he said, its demands will cause a lot of trouble. The measure may never come out of committee, he predicted.

Congressmen from the coal states added to the woes of the bill. They warned they will fight it unless it carries a ban on the "dumping" of gas by the pipelines.

As the House commerce committee wound up its second week of hearings its members were split into three camps:

. . . **One group believes** the bill as written is the best compromise that can be reached. It is against both administration and industry ideas for changes.

. . . **Another would permit** the Federal Power Commission to use cost in passing on contract prices. It might also accept review of existing contracts if the administration provision is modified.

. . . **A third group says** the administration didn't go far enough. The use of costs should be made mandatory.

Here is how the chances of the bill stand now:

It has a little better than even chance of being favorably reported by the committee if the administration will forego its amendment for review of existing contracts.

If reported out, no matter in what form, it will face a bitter fight on the House floor.

And there is little chance of the Senate taking up the gas problem until it sees how the bill fares in the House.

With only about 3 months of the session left, perhaps less, there is no expectation that the bill will go to the White House this year.

Foes are numerous . . . The Harris-O'Hara bill, even with the administration changes, isn't going to be acceptable to consumers. That was the word passed to the committee last week by a long line of state and city officials.

The committee listed 17 witnesses to speak in favor of the bill. But as it called opponents it was faced with more than twice that number. Included were the attorneys general of Wisconsin and Tennessee, 6 spokesmen for state utility commissions, 18 city officials and a handful of other interests.

Pace-setter for the group was Wisconsin's attorney general, Stewart G. Honeck. He charged the industry with jumping the gun in trying to get rid of federal regulation before giving it a "fair trial." It might turn out that producers wouldn't be as badly hurt as they fear they will be, he said.

Honeck charged that reasonable market value for gas, without consideration of costs, would be "more detrimental to the consumer interest than any prior bill."

Opponents agreed that independent producers should not be treated as public utilities. But they were not clear on how the FPC could use cost without getting into utility-type regulation.

Every major section of the bill was brought under attack. But some opponents indicated two possible ways in which the issue might be compromised.

The changes asked by the administration—use of cost by the FPC and review of escalations in existing contracts—would go a long way toward satisfying consumers, the committee was told.

A better solution, however, it was said, would be the release of small producers from all control and retention only of the some 61 companies which account for 80 per cent of the gas produced. Bills to that effect already are pending before the committee.

Is the market free? . . . The big issue in the gas question is whether there is a free market for gas in the field or is the market so dominated by the big oil companies that there is a monopoly, Honeck said.

If there is such a monopoly, federal regulation would afford better control than antitrust suits, he said.

Even if there is no monopoly, he made it clear, consumers want federal control of gas producers' prices.

The bill seems to bear "all of the outward appearances of an elaborate scheme of regulation," Honeck declared. "In substance it is no regulation at all.

"Its fatal weakness is that it seeks to apply the economic law of a free market to a market which is not free. Actually this bill does not regulate producers, it merely puts them out to pasture in a private corral surrounded by no-trespassing signs."

Honeck charged that there has been no fair opportunity to test regulation. Wisconsin, at least, is satisfied with the law as interpreted by the Supreme Court, he said.

The complaints against fair field price and other provisions of the bill brought comment from committee members that the consuming areas appear to have shifted ground since 1955. Then, it was pointed out, they were attacking escalation. They said if escalation was knocked all the Harris-Fullbright bill would be all right.

The fight against the bill could backfire against the states demanding rigorous regulation of producers, Rep. Martin Dies of Texas warned. If producers are discouraged from selling their gas interstate the result may be twofold, he said. The consuming areas may find themselves unable to get gas to meet expanding demands. And the migration of industry to the south may be stopped up.

Too much talk . . . The long and sharp questioning of witnesses by committee members opposing the bill has slowed the hearings to a walk.

The apparent effort to talk the measure to death brought a tart reminder from Chairman Oren Harris of Arkansas last week that while every opportunity to examine witnesses will be given "these hearings aren't going to run all summer."

A majority of supporting witnesses are yet to be heard. The long questioning of Charles H. Kendall, general counsel of the Office of Defense Mobilization; Jerome K. Kuykendall, chairman of the Federal Power Commission, and Russell B. Brown, general counsel of the Independent Petroleum Association of America, took up all of the 4 days originally assigned proponents.

The witnesses remaining to be heard will have to wait until the opponents have testified. But the committee is trying to speed things by holding sessions late in the day, even when the House is in session.

JOHN NEWTON, left, receives silver tray from WILLIAM NADEN of Esso Standard as ...

Refiners Honor Former A.P.I. Official

PHILADELPHIA.—A man who retired early this month—for 1 day—was honored last week for his long service to the oil industry and his many activities in the A.P.I.'s Division of Refining.

John W. Newton was presented a large silver tray by his colleagues on the refining division's general committee, which sets policy and procedures for the division. Newton is a former vice president of the division.

Newton retired as vice president of Magnolia Petroleum Co. on May 1. He remained retired all day May 2. But on the following day he was elected president, general manager, and a director of Norvell-Wilder Supply Co. He will continue to make his home in Beaumont, Norvell-Wilder's headquarters city.

The presentation was made in a surprise ceremony at a reception and dinner during the division's annual meeting here.

Three certificates of appreciation for service to the A.P.I. and its committees and for contributions to petroleum technology also were conferred here last week.

They went to Hugh W. Field, vice president in charge of research for Atlantic Refining Co., Philadelphia; J. Bennett Hill, retired director of research and development for Sun Oil Co., Philadelphia; and Daniel P. Barnard, research coordinator for Standard Oil Co. (Ind.), Chicago.

Hermosa Beach Lease Tops $11 Million

LOS ANGELES. — The Hermosa Beach city council has voted unanimously to accept a joint bid of Shell Oil Co. and Continental Oil Co. totaling $11,100,000 for drilling rights to the city's submerged lands.

The Shell-Conoco offer calls for a cash bonus of $6,600,000 for exclusive drilling and production rights for 35 years. It also calls for a cash bonus of $2,000,000 for use of certain city-owned properties for field offices and pipelines plus an annual rental on the properties of $100,000 per year.

The royalty provisions are on a sliding scale with a minimum of 16 per cent or $250,000 per year, which ever is greater.

The two companies also must pick up the tab for a special election nullifying a 35-year-old ban on drilling in the city.

Only offshore drilling from a mobile drilling barge or drilling platform is called for in the offer. The contract also guarantees against pollution or contamination of the ocean or beaches and against impairment or interference with recreational uses of the area.

Violence Erupts

● Texas drillers weather first outbreaks in unionists' drive to shut down rigs

SEAGRAVES, Tex. — Union rig crewmen continued to harass two Permian basin drilling contractors last week after first violence broke out in the union's campaign to bring basin contractors to heel.

Four leaders of Local 672 of the International Union of Operating Engineers were jailed at Seminole, Tex., on charges of destroying property and unlawful assembly. They later were released on bond.

They were O. W. Clark, union organizer at Odessa, Tex.; Tommy Hockler and B. W. Holley, Seminole; and Gene Mills of Seagraves.

The arrests were made and charges filed by Texas Rangers. They followed union harassment of a Cactus Drilling Corp. rig drilling a deep test 6 miles west of Seagraves in Gaines County for Anderson-Prichard Oil Co.

Union members leased about 3 acres of land near the rig through which passed the rig fuel line and the lease access road. Mills and Holley were jailed after a group of men cut off the rig's natural-gas supply by breaking the line. A budding battle royal was broken up quickly by watchful law-enforcement officials when the Cactus crew arrived to repair the line.

The Cactus rig switched to its emergency butane-fuel system and continued drilling. The line was repaired early last week by crew members following the arrests.

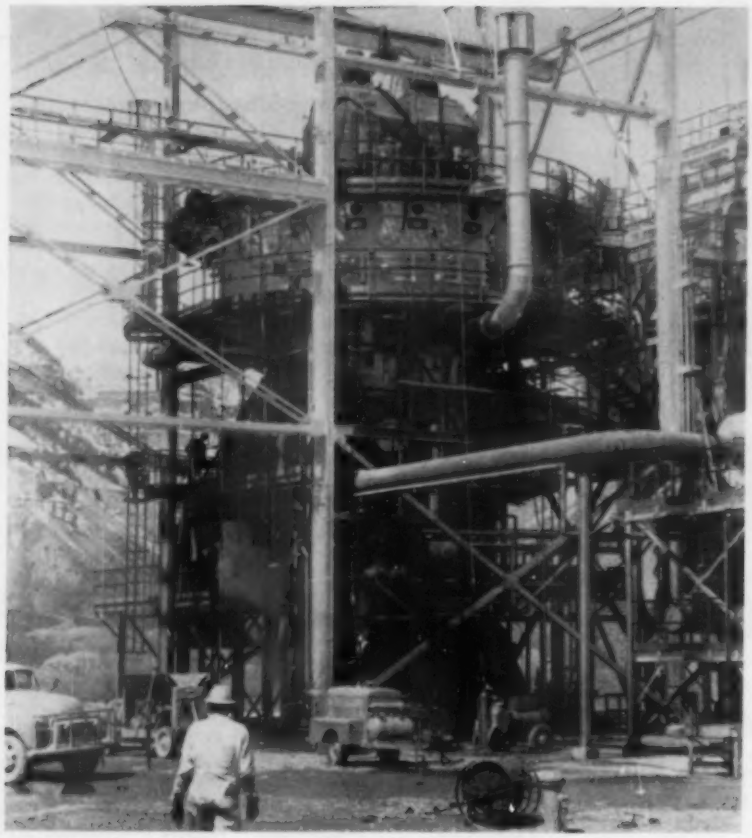
Meanwhile, union members plowed up the lease access road and erected a dirt barricade. Cactus countered with a bulldozer which quickly cleared the barrier.

Clark and Hockler were arrested on unlawful assembly charges during what the union termed was a "picnic." The gathering contained about 50 auto loads of union members on the site near the Cactus rig. The "picnic" quickly became mass picketing.

The situation, however, appeared to have quieted at midweek.

The union launched its current drive May 5 with a motorcade from Lamesa, Tex., to rig sites in Borden County. It has been picketing rigs of Cactus and Denver Drilling Co., Odessa, in the area since *(The Oil and Gas Journal, May 13, page 78).*

Labor's demands are for shorter work week, more crewmen, free transportation to and from rigs, safer rigs, and paid vacations.



INDUSTRY WATCHES to learn if Union's retort will open door to vast reserves as...

Big Shale Plant Goes to Work

GRAND VALLEY, Colo. — When Union Oil Co. of California began operations at its shale-oil experimental station near here last week, one question was uppermost:

Can the cost of producing oil from shale be cut enough to compete with crude oil?

A. C. Rubel, president of Union Oil, thinks it can. In fact, he believes the cost barrier might be penetrated within a year. The company has already spent $8 million in shale research. It took 2 years to build the big plant.

At stake is the world's largest deposit of commercial-grade shale. Success of the experiment could open up development of the vast shale beds in the Piceance Creek basin, which holds an estimated reserve of about 900 billion barrels of oil.

Shakedown tests which began in mid-April were called "extremely successful" by John Pownall, superintendent of the plant which is located 11 miles north of here in Parachute Canyon. There were only a few shutdowns for minor modifications.

Placing the plant on stream was the highlight of dedication ceremonies last week which attracted western governors and congressmen.

How it works . . . Shale particles, crushed to 4 in. and smaller, are fed through the bottom of the retort. A piston forces the shale to a point about midway up the retort, where the crushed rock is met by air being drawn downward by suction fans.

In the retorting zone, where temperatures reach about 800° F., the organic material, "kerogen," in the shale is converted to liquid oil and vapor. This collects and condenses on the cool incoming shale and is drawn off at the bottom and piped into storage tanks.

The shale residue continues upward in the retort, burning at a temperature of about 2,000° F. at the top, where it is removed in ash form.

The piston can handle about 2 tons of shale every 6 to 8 minutes, or from 360 to 480 tons daily. If the shale is of the mahogany-ledge type, 480 tons will yield 1,440 gal. of shale oil daily.

Byproducts are sulfur, ammonia, and noncondensible gas. This gas could be used to generate electricity to run retort machinery in a commercial operation.

Union Oil estimates construction of the first commercial plant would cost $200 to $300 million. Rubel envisions a thriving shale-oil industry producing about 2,000,000 bbl. daily within 5 to 10 years.

The shale is being strip-mined from a mountain 1,000 ft. above the plant. A primary crusher reduces it to 6-in. chunks in preparation of the 4-mile aerial tram trip down the mountain to a secondary crusher and screening tower. Then the shale is carried from a stockpile up a ramp to the top of the retort.

Other experiments . . . Union Oil's pilot station is the first large-scale development in the shale-oil industry in this country.

Oil Shale Corp., Beverly Hills, Calif., began operations at a 24-ton experimental station in Denver earlier this month *(The Oil and Gas Journal, May 13, page 77)*.

The plant was built by the Denver Research Institute of the University of Denver, under a $250,000 contract with Oil Shale Corp. The institute is trying to improve the new Swedish Aspeco flameless extracting process. Stearns-Roger Manufacturing Co. was contractor for both pilots.

Another experiment was conducted by the U. S. Bureau of Mines at Rifle, Colo., about 15 miles east of the Union site. But it was closed down 2 years ago after Congress refused to appropriate funds. The plant was transferred to the Navy last year.

Proposed legislation . . . Bills were laid before Congress last week which could affect both government and private shale interests.

One was submitted by Sen. Joseph C. O'Mahoney of Wyoming. It would give Navy $13.5 million and authority to operate the Rifle plant for 6 years. In the process, it would settle Navy's fight with Interior, which has been trying to get the plant back. The Bureau of Mines would carry out the actual research if O'Mahoney's bill goes through.

O'Mahoney's bill would mean a race between the Government and private industry to solve the problems of synthetic liquid fuels. But the Government would not go into the business of making and selling them. The bill prohibits Government competition in the field.

Bills were also introduced by three members of the Colorado delegation. They are asking for a 27½ per cent depletion allowance on shale and coal used to make liquid fuels. The bills are tied in directly with O'Mahoney's.

You can flood viscous crude

Pilot Test Succeeds

First attempt to increase recovery of heavy, viscous oil by water injection is encouraging, may lead to big flood

LOS ANGELES. — Union Pacific Railroad Co.'s pilot project at Wilmington is showing that fields producing low-gravity, highly viscous crude can be flooded successfully.

Union Pacific's pilot project, now 3 years old, was the first attempt by industry to flood a reservoir of highly viscous crude. Results to date indicate a substantial increase in ultimate recovery, the spring meeting of the Pacific Coast district of the American Petroleum Institute's Division of Production was told last week.

How to carry out water injection in as many as eight intervals through a single well was described in another address.

Union Pacific's pilot flood is in the Tar zone of the company's Wilmington properties. It has been so successful that a full-size flood may be started this year, either on a unitized or cooperative basis, C. C. Horace of U. P. told the meeting.

What's involved . . . Tar zone crude averages about 15° gravity. Under reservoir conditions of 126° F. and 600 psi. pressure, estimated viscosity is 240 cp.

Depletion of the reservoir makes the oil even more viscous. At zero pressure, studies showed it to be over 300 cp.

The project was started because of the anticipated low ultimate primary recovery in areas where there was no active water drive.

After injecting 4,500,000 bbl. of water through eight injection wells, it was determined that a pattern-type flood will be more effective than a flank flood, because of the viscous nature of the oil. In addition, substantially less water will be required.

Water bypassing will be severe, based on the pilot experiences, Horace said. Most of the secondary oil produced will be accompanied by high water cuts.

Multiple-zone injection . . . Injection operations carried out in the thick reservoir sections found in many California fields offer a problem: How to control the amount of fluid fed into each production interval.

Three Richfield Oil Corp. engineers, L. V. Gefvert, R. O. Chamberlain, and C. E. Wakefield, told how that company is doing it.

Multiple packers provide one method. Three concentric strings of tubing are run.

The bottom interval receives water or gas through 1¼-in. tubing. The middle pay is supplied through the annulus between the 1¼ and 2½-in. strings. The top pay is fed from the annular space between the 2½ and 4-in. external-upset tubing.

Through use of a hookwall packer and two cup-type packers, injection can be accomplished without having to subject the well casing to input pressures. A continuous surface record of the volumes of fluid injection into each interval is obtained by individual meters.

Using a single tubing string with multiple packers—as many as nine—Richfield is injecting water into as many as eight intervals, Gefvert said. Volume of water going into each sand is regulated by beans which can be replaced under pressure with a wire-line tool.

The input rate to individual pays in the 11 wells where the method is used has been determined most successfully by a surface recording spinner instrument.

Gefvert said it is positioned in the 2½-in. tubing immediately above each injection mandrel. The percentage loss of revolutions per minute in each progressively deeper pay is noted. From this the input rate to each interval is calculated. The equipment has been successfully run with surface pressures as high as 2,700 psi.

Savanna Gas Sold

El Paso, Westcoast hope to sign up entire output

NEW YORK. — El Paso Natural Gas Co. and Westcoast Transmission Co., Ltd., have signed up 60 per cent of the reserves of Savanna Creek field in Alberta, and contracts covering the remainder are expected to be completed soon.

Westcoast has contracted for 32½ per cent of the field acreage with Canadian Husky Oil, Ltd., and 27½ per cent with Phillips Petroleum Co. The bulk of the remaining acreage is owned by Northern Natural Gas Producing Co., subsidiary of Northern Natural Gas Co. Northern Natural has proposed a pipeline from Savanna Creek and other Alberta fields to Minneapolis, 1,200 miles away. But El Paso expects Northern to go along with the other producers in committing the gas to the Pacific Northwest market.

Paul Kayser, president of El Paso Natural, said his company had agreed to purchase $3 million of the common stock of Canadian Husky and to advance $2 million for development of the Savanna Creek acreage. The field is estimated to have reserves capable of producing 150,000,000 cu. ft. daily for 20 years.

Westcoast proposes to build a 174-mile, 30-in. pipeline from Savanna Creek to the Canada-U. S. border where the gas will be purchased by Pacific Northwest Pipeline Corp., an El Paso subsidiary *(The Oil and Gas Journal, January 14, page 66).*

Drilling Firm Sold

Canadian Homestead takes over Pennant in stock deal

TULSA.—Canadian Homestead Oils, Ltd., of Calgary has acquired Pennant Drilling, Ltd., in a stock-exchange deal. Canadian Homestead exchanged 850,000 shares of its common stock for the entire capital stock of Pennant Drilling.

The deal will give Crescent Corp., of Tulsa, the principal stockholder of Pennant Drilling, 642,625 shares of Canadian Homestead. This is about 24 per cent of the 2,700,000 Canadian Homestead shares outstanding.

Pennant Drilling will operate as a division of Canadian Homestead with no changes in personnel or policies, according to Clinton E. Wright, president of Pennant Drilling. New Canadian Homestead directors elected after the merger are Charles La Follensbee, Tulsa attorney; H. Ross Bolton and W. F. Styler, Jr., officers of Crescent; and Wright. Directors continuing are B. O. Jones, chairman; E. H. LaBorde, Canadian Homestead president; and Russell R. Rowles, Houston investment banker.

Pennant Drilling is operating five drilling rigs in Alberta and British Columbia. Its 1956 gross was $2,199,475. Canadian Homestead has oil and gas production in Alberta and Saskatchewan and land holdings of 2,555,000 gross acres in western Canada.

Labor Costs Rise

New 6 per cent pattern will add $175,000,000 to oil's wage bill this year; fringe benefits will add still more

OIL workers generally will get a 6 per cent wage increase this year. Several big oil companies set the national pattern last week, and it was quickly snapped up by organized labor.

For more than a half million refining and production employes it adds up to an extra 16 cents an hour plus 2 cents in fringe benefits.

The 18-cent "package" is one-third short of the goal set by the powerful Oil, Chemical, and Atomic Workers International Union. Nearly 6 months ago, O.C.A.W. laid down a 27-cent wage demand.

Here's what the new 6 per cent pattern will mean:

... **Oil companies will pay** an additional $3,375,000 per week in wages. Fringe benefits, on a 2-cent basis, will amount to another $420,000 weekly.

... **About 205,000 refinery** workers will be earning a national average of $2.84 per hour, as compared with $2.68 in January.

... **More than 320,000 production** employes will be making a national hourly average of $2.67, as compared with $2.52 in January.

As in other industries, the oil companies have been granting wage increases steadily since the end of the war. But compared with other manufacturing industries, oil workers are among the best paid in the nation (see table).

Here are the three main fringe benefits O.C.A.W. said it would accept:

... **Four weeks vacation** after 20 years, instead of 25 years.

... **Eight holidays** each year, instead of seven.

... **Double time and a half** for holiday work instead of double time.

Who's involved . . . O.C.A.W. announced acceptance of 6 per cent and these fringe benefits after confirming offers from Gulf Oil Corp., The Texas Co., Phillips Petroleum Co., Warren Petroleum Corp., Magnolia Petroleum Co., Humble Oil & Refining Co., Atlantic Refining Co., Carter Oil Co., and Esso Standard Oil Co. Other 6 per cent offers came from American Oil Co. and Ethyl Corp.

If the pattern sticks, as it has in past years, it will benefit not only the 105,000 members of O.C.A.W., but will spread to other industry employes, including white collar and supervisory personnel not represented by O.C.A.W. or independent unions.

Oil's Hourly Wage Trend

	Refining average	Production average	All mfg. average
1947	1.57	1.47	1.24
1948	1.79	1.67	1.35
1949	1.87	1.78	1.40
1950	1.93	1.82	1.47
1951	2.08	1.95	1.59
1952	2.20	2.09	1.67
1953	2.32	2.21	1.77
1954	2.37	2.27	1.81
1955	2.46	2.32	1.88
1956	2.65	2.48	1.98
Jan. 1957	2.68	2.52	2.05
1957*	2.84	2.67	....

*Based on 6 per cent of January 1957 average, as listed by the U. S. Department of Commerce.

Slow start . . . Six per cent is the amount which labor and management agreed to in 1956. But the general pattern was well established by mid-February last year.

Both O.C.A.W. and the Federation of Independent Oil Unions began hammering for big 1957 wage increases in December. O.C.A.W. wanted 27 cents and the federation sought 25 cents.

But management was reluctant to make counterproposals. Standard Oil Co. (Ind.) was the first to break the ice when it offered 4 per cent to the 6,300 members of the Independent Petroleum Workers of America, at the Whiting, Ind., refinery. O.C.A.W. began to get worried when I.P.W.A. accepted in March.

When the same offer was made to the 12,000-member Central States Petroleum Union, O.C.A.W. called a meeting with representatives of Central States. The 4 per cent offer was not accepted. However Central States did accept a 5 per cent offer early in May.

Five per cent trend . . . For a while it looked as though 5 per cent would be the national pattern. Companies began to make this offer late in March and it began snowballing in April.

Some O.C.A.W. bargaining units had accepted 5 per cent. They included refinery workers with Aurora Gasoline Co. and International Refineries, Inc., and marketing workers with Pure Oil Co. and Socony Mobil Oil Co. in the Detroit area.

But O.C.A.W. President O. A. Knight said these settlements wouldn't set a pattern because they were local or involved independent refineries.

Other companies offered 5 per cent, including Shell Oil Co., The Texas Co., Standard Oil Co. (Ohio), Republic Oil Refining Co., General Petroleum Corp., Sunray Mid-Continent Oil Co., Ohio Oil Co., Standard Oil Co. of California, The California Co., Pan American Petroleum Corp., and Phillips Petroleum Co.

Knight called a special "emergency" meeting of the 52-man bargaining policy committee early in May. At this meeting, they decided to hold out for 6 per cent.

Sun Oil Co. made the first 6 per cent offer to independent unions *(The Oil and Gas Journal, May 13, page 86)*. Then Gulf made the offer to O.C.A.W.

Last week, the big Standard Oil Co. (N. J.) family stepped into the new picture with a 6 per cent offer to O.C.A.W. bargaining units.

Other companies, including Phillips, Magnolia, and The Texas Co., upped their 5 per cent offers to meet the new trend. O.C.A.W. viewed it all as "a good cross-section of the industry."

Both labor and management had been keeping an eye on Sinclair Oil Corp., which has the only nationwide contract with O.C.A.W. The contract involves 10,000 Sinclair workers and expires this spring.

Sinclair had met with O.C.A.W. early in March, but nothing was settled, except that Sinclair rejected the 27-cent demand.

A second meeting is set for May 21 in Kansas City, Mo. This is just 2 days before expiration of O.C.A.W.'s 15-day strike notice.

Refinery struck . . . About 325 union workers walked off their jobs at Crown Central Petroleum Corp.'s refinery at Houston.

The dispute at the 35,000-bbl. plant involved "local issues," a union spokesman said. The company had offered a 5 per cent wage hike and 4-week vacation after 20 years.

Strike threats had been hanging over refineries on the Gulf Coast as well as the West Coast. Workers at The Texas Co. and the Gulf Oil Corp. plants at Port Arthur had voted for strikes, and there was also uneasiness about strike threats at Texaco's Wilmington, Calif., plant, and General Petroleum Corp.'s refinery at Torrance, Calif.

But this was before the 6 per cent pattern took hold. Differences may be ironed out as a result of the new pattern.

Paradox Extended

Utah wildcat flows crude at rate of 528 bbl. daily

BLUFF, Utah.—The Paradox basin producing trend moved to its westernmost point last week with Shell Oil Co.'s discovery of Upper Hermosa-Pennsylvanian oil at 1 Tohonadla in San Juan County, 8 miles south of here.

Shell's well flowed oil at an estimated rate of 528 bbl. daily on drill-stem test at 4,995-5,050 ft. Location of the significant strike is 6 miles northwest of North Boundary Butte field, 9 miles southwest of West Desert Creek field, and more than 20 miles from the east end of Aneth field proper.

Carter Oil Co. has acreage offsetting the Shell discovery on the north, west, and south. El Paso Natural Gas Co. and Atlantic Refining Co. also have acreage in the area.

Unitization Bill Pushed

SACRAMENTO. — The assembly committee on manufacturing, oil, and mining has unanimously approved a bill sponsored by Long Beach clarifying that city's right to participate in unit agreements.

The bill, which was introduced by Assemblymen William S. Grant and Herbert R. Klocksiem, specifies that cities with tideland grants can enter into unit agreements when oil production is causing subsidence, or where oil production can be boosted by unitization. Such unit agreements would be subject to the approval of the State Lands Commission.

On another front, in the war against subsidence at Long Beach Harbor, the Defense Department has asked Congress for $4,660,000 for subsidence remedial work at the Long Beach Naval Shipyards.

Sewage May Save Flood

Magnolia hopes to lick the water shortage in West Texas by treating Midland's sewage effluent for Pegasus flood

MIDLAND, Tex.—Magnolia Petroleum Co. was running first pilot tests here last week to see if Midland's sewage effluent is the answer to a vexing water-supply problem.

The problem is to find enough water for a full-scale flood in the big, unitized Pegasus field 23 miles south of here.

The unit is now injecting 8,000 to 10,000 bbl. of water daily in a pilot flood of Pegasus' Pennsylvanian and Ellenburger horizons.

The water is brine from the San Andres formation. There isn't enough of it for a full-size flood and, too, it's costly to treat to a satisfactory quality.

Magnolia, as operator of the 16,000-acre unit, signed up a more-than-adequate water supply early this spring. Midland approved Magnolia's proposal to take a 1-year option on the city's sewage-treatment plant effluent for a possible 30 years.

The company paid $25,000 for the option.

It has until April 1, 1958, to see whether it can treat the effluent and pipe it to Pegasus economically. Magnolia estimates it will cost about $1,500,000 to build a treating plant and an 18-in. concrete pipeline to move the water to Pegasus.

Company engineers have fabricated simple treating equipment at the Pegasus gasoline plant and are now using it in the pilot tests at Midland. The company will probably know in 5 or 6 weeks if this simple equipment will bring the water up to desired standards. If so, it likely will exercise the option in less than a year.

The pipeline to Pegasus will require by far the biggest slice of the cash, eating up all but about $200,000 to $300,000 of the total outlay.

Both to benefit . . . If the treating scheme proves economical, both the unit and the city stand to benefit.

Magnolia will have solved its Pegasus water problem and then some.

Water would be left for other projects—one of which might be a flood in Spraberry Trend area field sometime in the future. The company reportedly is impressed with early results obtained by a Humble Oil & Refining Co. flood there.

If Magnolia exercises the option, it would pledge itself to a 10-year contract with options to renew for four more 5-year periods.

The company would pay the city during the first 5 years 5.2 cents per thousand gallons. It would guarantee a minimum payment of $43,000 a year for the 5 years. The payments would scale upward to a point where the company would be paying 9 cents a thousand gallons during the last 5 years of the possible 30-year period. The minimum annual cash guarantee to the city then would be $75,000.

Midland's benefits wouldn't stop there. The city would get 365,000,000 gal. of treated water a year, or an average 1,000,000 gal. a day, free of charge to use as it sees fit.

The city presently plans to use this water to develop a municipal park and golf course.

Midland, in return, guarantees a minimum charge to the Magnolia plant of 3,800,000 gal. of effluent a day. This would give the company an average daily take of about 2,800,000 gal.., or nearly 70,000 bbl.

Floods helping . . . While Magnolia waits for the test results, the Pegasus flood pilots are proving that the water is needed.

The unit's pilot operation in the Pennsylvanian pay at 10,400 ft. has been expanded and inputs hiked from 4 to 12. The pressure drop and gas-oil ratio climb have been retarded in the pilot area. And oil output is gaining due to lessening g.o.r. penalties.

The Pennsylvanian input wells are taking an average of about 4,000 bbl. of water daily. The San Andres water is now treated at a plant in the field. There are about 90 wells producing from the Pennsylvanian pay.

The Ellenburger pilot still has only the initial one input well on the eastern edge of the field. The unit has been injecting about 4,000 to 5,000 bbl. of water daily through it in the deepest flood ever undertaken.

Response to injection has been favorable here, too, though not quite up to that in the Pennsylvanian. The unit originally planned to expand this pilot to a field-wide peripheral injection project if response was good.

Since these plans were made, however, an initially weak natural water drive has strengthened. And Magnolia thinks it can replace voidage with only a few more input wells.

West Gets Expensive

Slant holes and deep drilling are just some of the local problems making the hunt for oil cost more in California

LOS ANGELES.—Drilling costs in California, already above the national average, are bound to go higher.

With oil getting harder to find, there are three attractive areas left to the state's operators. And all of them take extra money to drill and produce. They are:

... **Highly developed** residential areas.

... **In the deeper zones** of known producing areas.

... **Offshore.**

This picture of what's ahead for California drilling was given in two papers presented at the spring meeting last week of the American Petroleum Institute's Division of Production, Pacific Coast district.

R. C. Sharp, Kellogg Overseas Corp., presented the cost story from the contractor's standpoint. John J. La Bouff, chief petroleum engineer of Signal Oil & Gas Co., gave the operator's side.

Why costs are up . . . Sharp said California costs are already on the border of being out of line with those in Texas, Oklahoma, and even the Middle East. If they get too far out of line, he warned, no company can or will look for oil in California.

He pointed out that the state's per-well costs are above the national average because the average California well is nearly 750 ft. deeper than elsewhere in the country. That's why California contractors drilled 5 per cent of the hole in the United States last year with only 4 per cent of the rigs.

Sharp said the cost picture is further complicated by difficult formations, increased directional drilling, and longer completion work. These conditions, he said, led to a 166-ft. daily average for footage drilled in California against a 226-ft. national average.

Residential drilling . . . Indirect costs run up the bill on this type of drilling. Some of the extras causing a heavier drain on the pocketbook are:

... **Soundproofing rigs.** This can add more than $10,000 to per-hole cost.

... **Waste disposal** requiring vacuum trucks exclusively.

... **Directional drilling** due to restricted drill sites. In most cases, multiple-well drill sites are mandatory.

... **Downtime due to restrictions** against certain night operations.

... **Expensive cellars** to house subsurface equipment and pumps.

... **Production-site landscaping.**

... **Constant inspection** of wells, lines, and tanks to guard against leakage or spillage.

... **Expensive well servicing** due to space limitations and lack of storage facilities.

Directional drilling . . . La Bouff said slant-hole drilling is costing nearly 50 per cent more on the average than normal, straight-hole drilling.

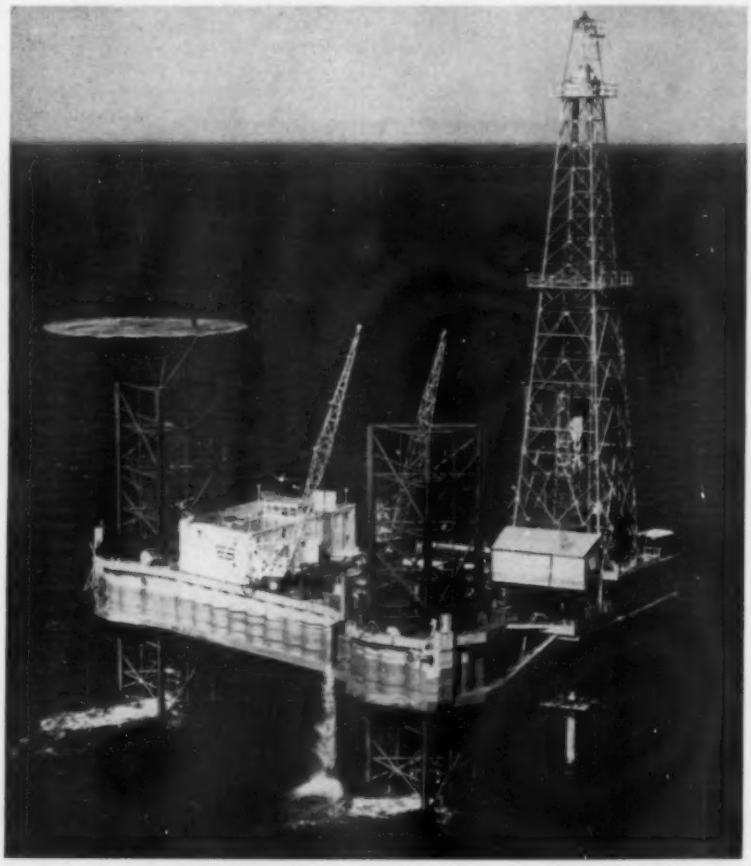
The slant-hole technique goes hand-in-glove with residential drilling, but there are still other reasons why it is growing in California. Deep-well operations in existing fields has promoted it. So has tidelands drilling.

When shooting for deeper pools in an old field, well sites are hard to find among the producers already there. This means the new wells have to be slant drilled from the outside.

Some of California's earliest tidelands wells, such as those at Rincon, were drilled from piers. Most of those put down since then, however, have been slant-drilled from onshore sites. Monterey Oil Co.'s wells at Seal Beach were slanted from an artificial island.

Offshore . . . In addition to the high costs inherent in offshore operations everywhere, California operators have some strictly local, and costly, problems of their own.

The state's tidelands extend out only 3 miles from shore. And water depths increase sharply only a short distance out.



New Arrival: The latest tripod drilling platform to join the offshore oil search is on its first location in Block 67 off the coast of Cameron Parish, Louisiana. Known as Vinegarroon, it was recently completed by R. G. LeTourneau, Inc., for Zapata Off-Shore Co. It is drilling for Sun Oil Co. Vinegarroon is the second of its type to join the Zapata offshore fleet. LeTourneau has three other tripods under construction at Vicksburg, Miss., and is negotiating on several more.

This means additional slant drilling to tap reserves underlying the deep water. It also means that the bulk of offshore operations are carried out close to valuable recreational beaches. As a result, the California offshore operator finds himself facing the same site-beautification restrictions imposed on land operators by beauty-conscious California residents.

Thus far, artificial islands have gained the most favor with California offshore operators. Based on the limited experience gained from one now in operation and another under construction, La Bouff estimated the cost of an earth-fill island in 40 ft. of water at $800,000 plus $10,000 for each well location.

Trans-Canada Link

Crown company lets four contracts for 310 miles

CALGARY.—Four contracts have been let for a big link in the Trans-Canada pipeline.

The section stretches 675 miles from the Ontario-Manitoba border to near Port Arthur, Ont. The contracts, totaling $15,556,429, cover the first 310 miles. They were let by the Northern Ontario Pipeline Co., a crown corporation formed by the federal and Ontario governments.

Estimated cost of the entire northern Ontario section is $120,000,000. The system will consist of 30-in. pipe. The new contracts cover Northern Ontario's program for this year. On completion, the section will be leased to Trans-Canada Pipe Line Co. with an option to purchase.

Successful bidders on the job were Dutton Williams Brothers of Calgary; Morrison Shivers, Ltd., of Leaside, Ont.; Majestic Contractors & Associates of Edmonton; and Houston Contracting Co. Here's the way jobs break down:

... **Dutton Williams Brothers** has a $3,678,776 contract to build spread A, a 57.7-mile stretch from the Manitoba-Ontario border west of Kenora to a point east of the crossing of Ontario Highway 17.

... **Morrison Shivers** will construct spread B, 94.1 miles, from the east crossing of Highway 17 to a line separating the townships of Hyndman and Hodgson. The contract is for $4,567,015.

... **Majestic Contractors** will lay 80.4 miles in spread C from the terminal of spread B to Stedman Township for $3,817,207.

... **Houston Contracting** will lay 78.5 miles in spread D from Stedman to Forham Township for $3,493,429.

Pipeline briefs

Portland Pipe Line Corp. has let contracts for station expansions to increase capacity of the dual 12 and 18-in. crude system by 15,000 bbl. per day. Present capacity is 237,000 bbl. per day from Portland, Me., to Montreal. The 75-mile Canadian section is Montreal Pipe Line Co., Ltd.

Pittsburgh Consolidation Coal Co. has the world's first coal-slurry pipeline operating again. The screening equipment which apparently passed oversize particles and caused the line to clog up in February now is working properly. There has been no trouble reported since the clogged section was broken out and the 400 tons of crushed coal removed. The coal-water mixture is being pumped 108 miles through an 8-in. line from Cadiz, Ohio, and Cleveland. The pipeline is expected to cut $1 a ton from rail-freight costs.

Mississippi River Fuel Corp. has lowered the sights on its 1957 expansion program. The company said the tight pipe supply resulted in withdrawal of its application with the Federal Power Commission to increase capacity 50,000 M.c.f. per day this year. A new application seeks authority for 10,000 M.c.f. per day instead, using 10,000 tons of premium pipe. New compressors totaling 6,300 hp. will be added. The company originally planned to lay 125 miles of loops along the dual system from Louisiana to St. Louis. The original line, laid in 1929, is 20-in. and the second line is 22 and 24-in.

Cosden Petroleum Corp.'s Onyx Division will build a gathering system and main line to transport crude from Taylor County, West Central Texas, which is now being trucked to the 6,000-bbl. Onyx refinery at Abilene. There will be 37 miles of 4 to 6-in. main line and 15 miles of gathering lines. Construction will begin as soon as the ground dries out from recent heavy rains. The line is to be operating by July 1.

El Paso Natural Gas Co. will buy the McElroy-Wilshire gasoline plant and related pipeline facilities from Lone Star Producing Co. in Upton County, Texas. The F.P.C. authorized the deal and gave El Paso a permit to build 38 miles of various diameter pipelines, add 2,640 hp., and expand the plant to process high liquid content gas. El Paso and Hunt Oil Co. will share cost of the venture—$1,150,000 for the purchase and $2,568,000 for new facilities.

Atlantic Seaboard Corp., Charleston, W. Va., has temporary FPC authority to build $3,061,000 in natural-gas facilities in West Virginia to take 25 M.M.c.f. per day from Transcontinental Gas Pipe Line Corp. Atlantic will lay 14 miles of 26-in. loop and install 2,000 hp. at its Cleveland compressor station and 2,000 hp. at Files Creek station.

Also for Pipeliners . . .

Texas pipeliners are now telling their story in a battle with producers before the Railroad Commission. They say producers really want a market for their crude and not transport (P. 110) . . . Colorado Interstate claims it faces bankruptcy if rates set by FPC examiner are allowed to stand. It means a $15 million annual rate cut plus refund of $33 million (P. 114) . . . Buckeye is planning a 70-mile, 8-in. products line from Wayne to Durand, Mich. (P. 115) . . . A drawn-out battle is assured before FPC finally rules on who'll get a big slice of the upper Midwest gas market. Hearings will continue until next winter (P. 116) . . . Chances of the Harris-O'Hara gas bill ever reaching the White House this year are fading fast (P. 120) . . . El Paso and Westcoast have signed up 60 per cent of gas reserves in Savanna Creek field and expect to get the remainder soon (P. 123) . . . Four contracts have been let for a big link in the Trans-Canada pipeline (P. 127) . . . First oil brought from Safaniya field in the Persian Gulf through a 140-mile pipeline has been lifted by a Japanese tanker (P. 129) . . . Nine smaller American companies with Middle East interests have now been cut in on planning for the new big-inch Middle East crude line (P. 130) . . .

PLUS THESE TECHNICAL FEATURES: Study on pressure-surge problems leading to better designed pipeline systems (P. 173) . . . and Pipeline Patrol's report on special pipeline steels that can be welded without preheating and have a weld-joint efficiency of 100 per cent (P. 209).

Venezuelan Leases Still Go Begging

- **Startling facts now revealed on latest bidding: Only half the land sought and cash is paid on less than that**

- **Americans form syndicates to share high costs of play, some make unusual agreements to win choice acreage**

THE dust raised by the latest scramble for concession acreage in Venezuela had pretty well settled by the end of last week. And some rather startling figures showed up.

Late in January, the Venezuelan Government told interested oil companies it would accept bids on about 2,500,000 acres of land. The offering included both exploratory and development tracts, and minimum prices were set for both types of bids. Many companies who were interested took a look at those minimums and decided the price was too high.

Lake Maracaibo was included in this offering, but this time four other areas of the country were opened up for the first time in more than 11 years. In spite of the high price tags on some pieces of land, the offer sent a group of new companies, many of them smaller American independents, flocking to Venezuela. Some of them were successful, usually in a group of partnership bid. The established companies took the big share of the new acreage.

In a number of cases the apparent high bidder did not put up his money within the 8 days granted by the Ministry of Mines and Hydrocarbons. Several locally formed Venezuelan companies are in this group. At least one of these was still insisting last week that it would get the acreage on which it submitted bids.

Here's how the situation shaped up by last week:

... Half the land offering went begging. No bids were submitted on at least 49 per cent of the 2½ million acres.

... Only 34 per cent of the land bid on actually had been tied up last week by money in the hands of the Venezuelan Government. Successful bids on 17 per cent of the acreage still have not yet been paid.

... $343,473,000 in bids have been paid into the Venezuelan treasury. This is apart from another $727,000 in bonuses which companies paid for another 370,000 acres of border concessions which went along with choice acreage as a package deal insisted on by Venezuela.

... Underwater prospects looked best to the companies. The Lake Maracaibo and Gulf of Paria tracts accounted for 68 per cent of total bonuses paid. These two areas accounted for only 21 per cent of the total acreage offered.

Phillips group . . . A group of eight companies headed by Phillips Petroleum Co. is the latest to receive an official award.

The group is typical of how the smaller independents went into Venezuela. Phillips is the only company in the group which is now operating in the country.

The group paid $32,357,000 for Lot 17 in Lake Maracaibo. The price paid on this 10,000-hectare tract (24,700 acres) was $1,310 an acre.

A second 10,000-hectare block in Temblador area of southern Monagas was picked up by the group for $11,362,000, or $460 an acre. In addition the group took two more 10,000-hectare tracts along the Colombian border in one of the package deals being promoted by the govern-

Who Paid How Much for What

SOUTH MONAGAS

Block	Approx. Area (acres)	Bidder	Price per Acre
1	24,700	Davis Oil Corp.	*
9	24,700	Phillips group	$460
10	24,700	Creole	263
11	24,700	Pan Venezuelan	275
19	23,465	Davis Oil	*
20	19,760	Davis Oil	*
25 thru 27	74,100	Petrovica	*
28	24,700	†Pan Venezuelan	590
30	19,760	†Pan Venezuelan	524
31	24,700	Creole	250
32	27,170	Creole	250

*Apparent high bidder but bid still not paid.
†Pan Venezuelan ⅗ and Sun Oil ⅕.

NORTH MONAGAS

Block	Approx. Area (acres)	Bidder	Price per Acre
1	29,640	Pegaven	*
3	24,700	Petrovica	*
4	24,700	Corp. Venez de Minas	*
5	72,865	Creole	$210

*Apparent high bidder, but bid still not paid.

LAKE MARACAIBO

Block	Approx. Area (acres)	Bidder	Price per Acre
10	24,700	†San Jacinto	$1,965
12	24,700	‡Sun Group	1,325
17	24,700	§Phillips Group	1,310
20	24,700	Petrovica	*1,310
21	24,700	Petrovica	*1,440
24	24,700	Petrovica	*1,570

*Apparent high bidder, but bid still not paid.
†San Jacinto, 25 per cent; Phillips, 45 per cent, and remainder held by El Paso Natural Gas, Western Natural Gas, Sunray Mid-Continent.
‡Sun 23⅓; Seaboard Oil, 10 per cent; Atlantic, 33⅓ per cent; Pan Venezuelan, 33⅓ per cent.
§Phillips 55.75 per cent; Sunray Mid-Continent, 17.27; Ashland Oil, 10.79; Western Natural Gas and El Paso Natural, 6.47; Kerr-McGee, 5.40; Pacific Petroleums and Canadian Atlantic, 4.32.

GULF OF PARIA

Block	Approx. Area (acres)	Bidder	Price per Acre
7	22,230	Pan Venezuelan	$210
9	24,700	*C.T.O.C.R.	243
10	24,700	*C.T.O.C.R.	1,036
11	24,700	*C.T.O.C.R.	607
12	24,700	*C.T.O.C.R.	611
13	24,700	*C.T.O.C.R.	814
14	24,700	*C.T.O.C.R.	696
15	24,700	Shell	476
16	14,820	Atlantic	355

*Continental 25 per cent; Texaco, 25 per cent; Ohio, 25 per cent; Cities Service, 16⅔ per cent, and Richfield 8⅓ per cent.

BARINAS

Block	Approx. Area (acres)	Bidder	Price per Acre
1	29,640	Empresa Nacional	*220
3	28,400	Empresa Nacional	*220
5	24,700	Corp. Venez. de Minas	*236
11	10,800	†Atlantic	56
22 thru 24	148,200	Creole	56
26	49,400	King-Mill	85
27	54,340	Atlantic	65
28	49,400	Creole	138

*Apparent high bidder, but bid not yet paid.
†Atlantic, 33⅓ per cent; Pan Venezuelan, 33⅓ per cent; and Sun Oil Co., 33⅓ per cent.
Note: Blocks 22 through 28 are exploratory concessions.

ment to push development of outlying areas.

Phillips will act as operator of the group and will own 55.75 per cent of the operation. The other companies involved and their percentages of interest are: Sunray Mid-Continent Oil Co., 17.27 per cent; Ashland Oil & Refining Co., 10.79 per cent; Western Natural Gas Co. and El Paso Natural Gas Products Co., 6.47 per cent together; Kerr-McGee Oil Industries, Inc., 5.40 per cent; Pacific Petroleums, Ltd., and Canadian Atlantic Oil Co., Ltd., 4.32 per cent shared.

Unusual agreement . . . Phillips agreed to several special conditions in dealing for Lake Maracaibo Block 17 which will help Venezuela promote a plastics and atomic-energy industry.

Phillips granted Venezuela free use of its patent on Marlex-50 and agreed to furnish technical help needed for building a plant and operating it to produce the plastics material. Phillips also agreed to supply technical cooperation in obtaining radioactive isotopes and setting up atomic-energy experiments in the country.

The agreement fits Venezuelan plans to expand the country's industrial base and build a vast petrochemical complex at Puerto Cabello *(The Oil and Gas Journal, April 22, page 97).*

Block 10 . . . One Lake Maracaibo tract was still being disputed last week in some quarters. But official reports from Caracas indicate it will go to a group headed by San Jacinto Petroleum Corp., Houston, with every indication that Phillips will have the major participation.

Block 10 was first bid in last year by Venezuelan American Independent Oil Producers Association at $786 an acre. The award was never made because VAIOPA failed to back up its bid with the money. The tract was included in the new offering February 11, and it started all over again.

The first bid reported in Caracas was submitted by Mex-Amer, a combine of Mexican and American capital which offered $1,965 an acre for the tract. Mex-Amer failed to put up the money in the required 8 days, and a local Caracas firm announced that it had secured the acreage.

Petrolera Venezolano Internacional, C.A. (Petrovica), announced in Caracas that it had submitted the successful second bid for Block 10 and also for Blocks 20, 21, and 24. Petrovica also failed to meet the 8-day deadline on financing.

Last week, long after Caracas reports had conceded Block 10 to San Jacinto at the same price first offered by Mex-Amer, officials of Petrovica visited New York banking circles seeking financing. They disputed the San Jacinto reports and insisted that Petrovica would still be awarded Block 10.

But the Gaceta Oficial in Caracas later announced award of the block to the San Jacinto group. Phillips then announced it would serve as operator and revealed this split in ownership: Phillips 45 per cent; San Jacinto 25 per cent; El Paso Natural Gas Products Co. 10 per cent; Western Natural Gas Co. 10 per cent; Sunray Mid-Continent Oil Co. 5 per cent; and Pacific Petroleums, Ltd., 5 per cent.

What Happened to All Lands Offered in Venezuela

	Acres offered	Per cent of total	Per cent of acreage bid: No bid	Bids unpaid	Bids paid	Payment	Per cent of total
Lake Maracaibo	148,000	6	0	50	50	$113,620,000	33
Gulf of Paria	380,000	15	45	0	55	120,660,000	35
South Monagas	786,000	31	60	21	19	62,545,000	18
North Monagas	291,000	12	48	37	15	15,301,000	5
Barinas	911,000	36	49	12	39	31,347,000	9
Total	2,516,000	100	49	17	34	$343,473,000	100

Middle East's First Offshore Oil Lifted

THE first tanker load of Safaniya crude, pumped through a new 140-mile pipeline from the offshore Persian Gulf oil field, was lifted early this month by the Japanese tanker, M.S. Nissyo Maru.

The occasion called for all the proper ceremonies and H. H. Amir 'Abd al-Muhsin ibn Jiluwi, representing the governor of the eastern province of Saudi Arabia, turned the valve which started the tanker loading. Pictured above from left to right are Capt. Tatsuo Nitta of the tanker; L. H. Rushmer, Aramco district manager of Ras Tanura; H. H. Amir 'Abd al-Muhsin ibn Jiluwi; R. L. Keyes, Aramco president; Shaikh Sa'ud al-Dughaithir, deputy minister of finance for the eastern province; and Shaikh Turki al-'Utaishan, acting director of labor and labor affairs in the eastern province.

Safaniya, probably the world's largest underwater oil field, is now producing about 50,000 bbl. daily. It is expected to be moving 125,000 bbl. daily to Ras Tanura by the middle of this year *(The Oil and Gas Journal, April 22, page 98).*

Interest in Line Grows

Nine smaller American oil firms join "the big eight" in London conference planning new Middle East oil pipeline

THE number of companies involved in planning the 1,500-mile, $840-million, big-inch pipeline from the Middle East to the Mediterranean has more than doubled.

The nine smaller American companies which hold a 5 per cent interest in the Iranian consortium sat down with the world's majors in London last week to discuss the pipeline plans. Two of these have interests in the Middle East outside Iran.

Broadening the base for the discussions now has 17 oil companies, 14 of them American, sitting around a conference table, talking in millions of dollars, millions of barrels of oil, and hundreds of miles of pipeline.

The talks were begun 2 months ago by the world's eight big companies. The primary idea is to build a pipeline to move as much Middle East oil as possible to a point on the Mediterranean where it can be transshipped to Europe by tanker. The Suez Canal already has proved itself a bottleneck to oil transport.

Another block is the have-not Arab nations which are now crossed by the Middle East's pipeline systems. Apparently a line from the producing countries northward to Turkey and then east to the Mediterranean will get the nod *(The Oil and Gas Journal, December 3, 1956, page 66, and March 25, 1957, page 117).*

Plans for line . . . The whole thing is still in the talking stage, but the "big eight" have now been joined formally by the other companies with Middle East interests.

They are now talking in terms of a double 38-in. or 40-in. pipeline that will move up to 1,400,000 bbl. of oil daily.

The spokesmen for companies meeting in London emphasize that such a line would supplement existing oil-moving facilities rather than replace them. This is an obvious effort to avoid stirring up further trouble in already volatile areas of Jordan, Syria, and Lebanon which the present pipeline systems cross.

Those same spokesmen are quick to point out that last week's meetings are still very preliminary.

Many problems still have to be worked out. But the invitation to the smaller companies to participate is believed significant.

A pipeline such as the one now being discusses has the semiofficial support of the governments of both the United States and Great Britain. The big hurdles would be the million tons of steel necessary to build such a line, the financing, and all the necessary political agreements to make it work to the satisfaction of all the countries involved.

Who's involved . . . In London the 17 companies studied the preliminary reports of these problems compiled by subcommittees appointed in March when the first meetings were held. Those meeting were attended by people from Standard Oil Co. (N.J.), Standard Oil Co. of California, The Texas Co., Gulf Oil Corp., and Socony Mobil Oil Co., the big American majors, plus British Petroleum Co., Cie Francaise Des Petroles, and the Royal Dutch-Shell Group.

Last week the majors were joined by Atlantic Refining Co., Hancock Oil Co., Getty Oil Co., Richfield Oil Corp., San Jacinto Petroleum Corp., Signal Oil & Gas Co., American Independent Oil Co., Standard Oil Co. (Ohio), and Tidewater Oil Co.

This group of nine companies holds a 5 per cent interest in the Iranian oil operation through Iricon Agency, Ltd. Because Iricon owns only 5 per cent of the entire Iranian consortium, the individual interests of the nine companies are small, but in terms of oil and oil potential these interests can loom pretty big.

Shell Enters Central Bolivia

SHELL PROSPECTING CO., LTD., last week became the fifth foreign oil company to enter Bolivia since the country adopted its present oil code in October 1955.

The Shell company was granted exploration licenses covering 2,000,000 hectares (about 4,740,000 acres) on the eastern flank of the Andes Mountains in central Bolivia. The acreage, in two concessions, was granted after Shell first did surface exploratory work in the country on a nonexclusive basis *(The Oil and Gas Journal, November 5, 1956, page 85).*

Both tracts granted last week lie north and east of Santa Cruz and to the north and east of the country's established production.

One block of the Shell land north and east of Santa Cruz is about 1,135,000 acres. The other is more than 3,600,000 acres and runs north and east of the town of San Antonio. The company has immediate plans for an aerial survey of the acreage along with surface geological and geophysical work.

Gulf breaks ice . . . Before the new code was passed, Bolivia's oil was in the exclusive hands of the state agency, Yacimientos Petroliferos Fiscales Bolivianos. The country expropriated the holdings of a subsidiary of Standard Oil Co. (N. J.) in 1938 and after that time no foreign companies operated in Bolivia.

Glenn McCarthy, Houston independent, signed a contract with Y.P.F.B. giving him operating rights in southern Bolivia before the passage of the new oil law, but his efforts have failed to develop a major field. Bolivian Gulf was the first major company to enter the country. Others followed.

Bolivian Gulf got contract exploratory rights to 3,750,000 acres in the area of the country reserved for the government agency. In addition, Gulf received another 4,000,000 acres of outright concession lands to the north and west of the Y.P.F.B. reserve.

In return, the company agreed to help Bolivia with $5 million in the financing and building of a 201-mile pipeline from Sicasica to Arica on the Chilean coast. This would give landlocked Bolivia an outlet for its crude.

Gulf is making plans now to move a rig into the country and start its first well.

Three Tulsa firms have interests in the Gulf deal. Falcon Seaboard Drilling Co. and Barry & Reiner, Inc., each have 7 per cent and Williams Brothers has 6 per cent.

Just a short time before the Shell award was disclosed, three other American companies received an award of 1,232,000 acres in the region southeast of Santa Cruz.

Standard Oil Co. (Ohio), Pure Oil Co., and Hancock Oil Co. each have a one-third interest in the operation. The concession was granted to Andes Oil Co., a Pure subsidiary *The (Oil and Gas Journal, May 6, page 97).*

Panama Gets Refinery

● Du Pont, Shaheen find 55,000-bbl. project attractive, with ready market, built-in price spread, and low taxes

TWO East Coast investors last week took the wraps off a 55,000-bbl. refinery project for Panama that probably will have oil men talking for months to come.

John Shaheen, New York, and Eugene du Pont III, Wilmington, owners of Panama Refining & Petrochemical Co., Inc., capped more than a year of preliminaries by signing the construction contract for the country's first refinery with Foster Wheeler Corp.

Work on the plant at a deep-water site will start in 60 to 90 days. It is scheduled to go on stream by June 30, 1959. Total cost will be more than $33,000,000.

Shaheen and Du Pont have put $1,400,000 of their own into the project, including $700,000 initially paid to the Panamanian Government. Banks and insurance companies are putting up the rest.

Here is why the project looks attractive:

...A tax umbrella is guaranteed for 25 years. No income taxes will be levied on exports. The bulk of the output will be exported. The local property tax is negligible. The import duty on crude is 1 cent per barrel.

Ten-year sales contracts are in hand for 37,000 or 38,000 bbl. daily. The one exception is a 7-year contract with a year-to-year option. A 10-year crude supply also is contracted for. Other sales contracts are under discussion.

... Major companies have agreed to provide the crude and buy the products.

Break-even point is 20,000 bbl. daily throughput. Payout time will be 4½ years.

Three majors will supply the crude from Venezuela and Colombia. One company has the right to supply 10,000 bbl. daily from the Middle East. It expects to exercise its option to supply Caribbean crude, however.

The same three majors along with three independent companies, will buy the throughput.

Shaheen and Du Pont are limiting themselves to the money-management end of the business. Products will be sold at the refinery gate. An American independent refining company will manage the plant. Three are being considered for the job.

Products . . . From 50 to 60 per cent of the yield will be bunker fuel and marine diesel oil. The balance will be light ends, including three grades of gasoline—regular, premium, and super. The super will be made in small amounts for local consumption.

The Panama Canal Zone is expected to be one of the biggest markets for refinery output. The area is considered an export market and no taxes will be levied for products going there. Present canal demand for bunker fuel and marine diesel oil is 22,000 bbl. daily.

Plans initially called for the manufacture of aviation gasoline to supply the local market. But with the use of jet transports looming the company decided to forego the avgas market for a few years, rather than build an alkylation unit which might soon become dated.

Silver lining:
Suez Closing Puts Zip in Bunker Stop

CAPETOWN was one of the few places not to suffer during the shutdown of Suez Canal.

Diverted tankers and other vessels calling on the South African bunkering station brought a wave of prosperity that still hasn't ebbed.

Almost 1,300 ships more than normal have stopped for fuel, repairs, and stores since November. They have added an extra $2,800,000 to the port's revenue.

Even with Suez reopened, the city thinks it will take some time to get ahead of routine work and in general to catch its breath.

German to Explore Canada

A West German independent has acquired 10 concessions in Saskatchewan covering about 1,000,000 acres.

Wintershall, A.G., Kassel, obtained six blocks in the central part of the province in an area unproductive so far. The acreage lies southeast of North Battleford and northeast of Kamsack. The other four blocks are west of Regina.

Exploration work will be carried on by a subsidiary, Ceepee Oil Co., Ltd., with headquarters at Regina. Drilling operations may begin next year.

———*World* briefs

A West German wildcat has located a new gas field 20 miles east of Munich. The 2 Albaching, drilled by Mobil Oil, A.G., flowed on production tests at the rate of 2,500 M.c.f. daily from 8,166-8,205 ft. The nearest production to the discovery is 6 miles north, at Isen gas and oil field.

Gewerkschaft Erdoel-Raffinerie Emsland is adding a 5,000-bbl.-daily combination distillation unit at its 15,000 - bbl. - daily Lingen - Holthausen plant. The unit will enable the company to step up diesel-oil output for the West German market. It will go on stream in mid-1958.

Shell-BP Petroleum Development Co. of Nigeria will take another look at the Benin City area of western Nigeria later this year. The company is moving in an Ideal 100 rig for a deep test 16 miles south of the city. It abandoned its last well in the region 3 years ago after a noncommercial show at 6,387 ft.

Foster Wheeler, Ltd., will build a $25,000,000 petrochemical plant at Esso Petroleum Co., Ltd.'s, United Kingdom refinery at Fawley. The plant will be the first to produce chemicals with the fixed-bed Houdry dehydrogenation process under the license recently obtained by Esso Research & Engineering Co.

The Universe Commander, sister ship to the 84,730-ton Universe Leader, has been launched at Kure, Japan. The ship was built by National Bulk Carrier, Inc., which has the shipyard under lease. Five more of the 84,730-tonners are scheduled.

Petroleos Hondurenos, S. A., has been sold to a syndicate of seven oil firms. The company owns an 11,000,000-acre concession in the states of Santa Barbara and Olancho in Honduras. Purchasers are Georesearch, Inc., Col. D. Harold Byrd, American Maracaibo Co., Oil & Gas Property Management, Inc., Justiss-Mears Oil Co., Western Hemisphere, Inc., and McRae Oil & Gas Corp.

Morocco will buy Russian crude for the first time under a newly signed trade agreement. Deliveries will amount to about 350,000 bbl. this year. The Northwest African country, formerly a French protectorate, set up a representative government in 1955.

Beginning

A.P.I. MIDYEAR REFINING REPORT

Isomerization Adds to Your OCTANE PICTURE

"Production of isopentanes not only offers the refiner an excellent means of meeting research octane-number requirements, but gives him a superb component with very high road antiknock properties for superpremium fuels."

by H. R. Grane, J. K. Ozawa, and G. R. Worrell

THE conversion of n-pentane and n-hexane to their isomers give a very substantial octane increase. The Pentafining process effects this isomerization with little yield loss. The selectivity of the catalyst is demonstrated with once-through yields for C_5's and C_6's.

- To achieve a higher gasoline pool octane, isomerization is compared to increased severity for catalytic reforming. Although isomerization is considerably more costly over a range of pool-octane levels, a point is reached where the economics change very rapidly, and isomerization facilities should be installed.
- Isopentane is one of the few components that can be blended into superpremium fuels. The road octane blending value, as well as the research octane-number rating, is well above 100.

In the past several years, catalytic reforming has received such general acceptance that most of the 180° to 400° F. straightrun naphtha available in crude oil is now being reformed. The 80° F. to 180° F. fraction has changed from its former position as the highest-octane portion of motor gasoline to its current status of being the material that must be upgraded to further increase pool octanes. It is expected that catalytic isomerization of the 80° to 180° F. fraction will be widely accepted in the next few years.

Several articles have been published to illustrate the application of Pentafining to the isomerization of n-pentane.[1 2 3 4] The purpose of this paper is to present data on n-hexane isomerization and to show how and when C_5 and C_6 Pentafining should be installed in a typical refinery.

Catalyst Performance

Pentafining catalyst is a combination of platinum, silica, and alumina specifically designed for isomerization operations. The performance is shown by Fig. 1, where once-through yields and quality of product are plotted for C_5 and C_6 feed stocks. The parameters used are the per cent by weight of butane and lighter yield and the per cent by volume of isomers in the product having the same molecular weight as the charge. It is evident that isomer content of the product can be increased to a certain point with only minor losses to butane and lighter. As chemical equilibrium is closely approached, gas loss increases very sharply, so operations are conducted enough below equilibrium to take advantage of the high yield.

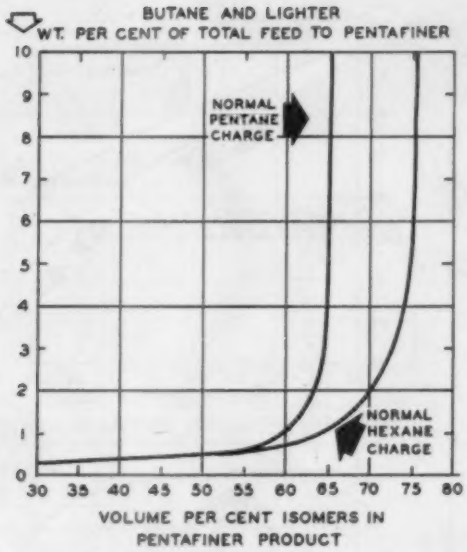
Detailed breakdowns of single-pass yields are shown in Table 1. It should be noted that production of all hydrocarbons lighter and heavier than the charge is minimized.

Process Design

Because of the number of different hydrocarbons to be considered in a C_5 and C_6 feed stock, detailed calculations are required to establish the optimum processing scheme. Fig. 2 is a flow diagram of Pentafining and

Authors are with Atlantic Refining Co., Philadelphia. Paper presented at midyear meeting of the A.P.I. Division of Refining at Philadelphia, May 15, under the original title, "Isomerization Adds to Your Octane Picture."

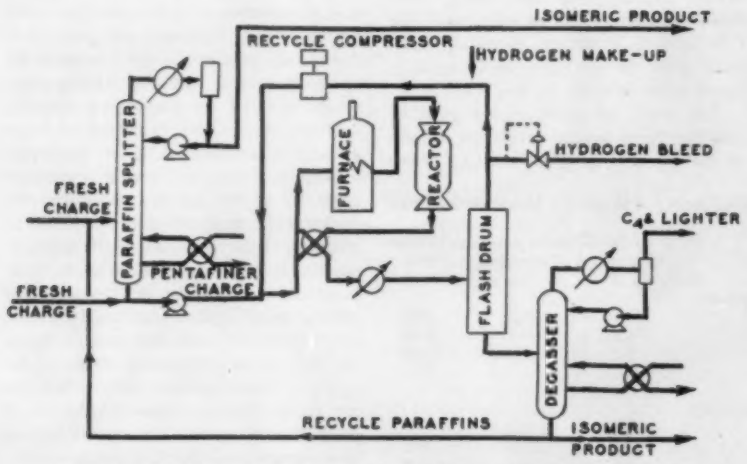
REFINING


BUTANE AND LIGHTER
WT. PER CENT OF TOTAL FEED TO PENTAFINER
NORMAL PENTANE CHARGE
NORMAL HEXANE CHARGE
VOLUME PER CENT ISOMERS IN PENTAFINER PRODUCT

ONCE-THROUGH YIELDS and quality of product for pentane and hexane isomerization Fig. 1.

TABLE 1—TYPICAL ONCE-THROUGH YIELDS FROM PENTAFINING

Feed—	n-Pentane		n-Hexane	
Yields—	Per cent by wt.	Per cent by vol.	Per cent by wt.	Per cent by vol.
Methane	0.1	....	0.1	....
Ethane	0.1	....	0.2	....
Propane	0.1	....	1.2	....
Isobutane	0.1	....	0.2	....
n-Butane	0.6	....	0.3	....
Isopentane	58.9	59.5	0.1	....
n-Pentane	39.6	39.6	0.9	....
Isohexanes	0.5	....	67.3	68.0
n-Hexane			29.5	29.5
C_7 and heavier	0	....	0.2	....
Total	100.0	99.1	100.0	97.5
C_4 and lighter, per cent by weight	1.0		2.0	
Isomers in product, per cent by volume	60.0		70.0	



FLOW DIAGRAM of Atlantic Refining Co.'s Pentafining process. Fig. 2.

some of the associated fractionation, which illustrates a few of the possibilities. Separate C_5 and C_6 streams may be processed in the manner shown. Each stream, for instance, could be charged to a splitter to concentrate the n-paraffins, or could be charged directly to the Pentafiner. After isomerization, the product could be recycled to the splitter or taken directly to gasoline blending. In addition, C_5 and C_6 n-paraffins could be isomerized in the same reaction section if economics so dictate.

To split or not to split . . . Fig. 3 illustrates one phase of the calculations to determine the optimum way to process the C_6 fraction. Typical feed stocks of varying n-hexane content were calculated through two routes:

1. Once-through Pentafining without prior fractionation.

2. Once-through Pentafining after splitting.

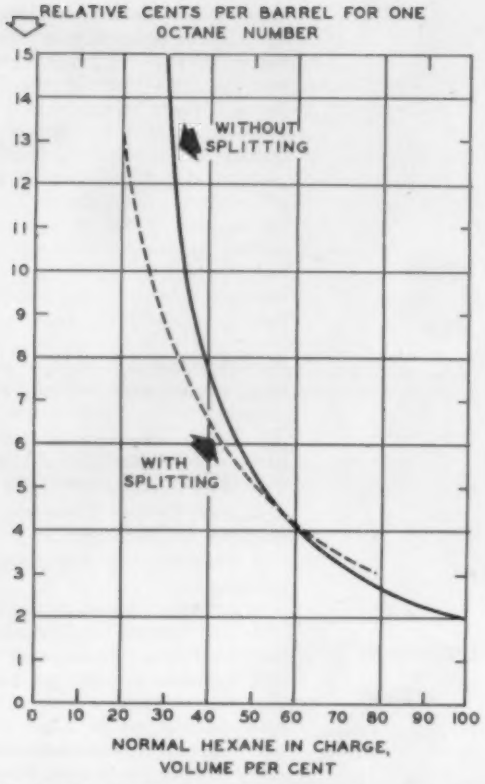
Investment, operating cost, yield loss, and octane improvement were calculated and incorporated into a cost measured in cents per barrel for each research octane-number increase with the addition of 3 ml. TEL per gal. The cost of fractionation to separate the C_6 fraction from crude oil is common to both routes and is not included. The cost in cents per barrel for one octane number is plotted against the n-hexane concentration in the feed.

Breakeven point . . . It may be seen that the breakeven point occurs at approximately 55 per cent n-hexane. At higher concentrations there is an advantage in passing the total feed through the Pentafiner. At lower concentrations there is a substantial driving force for splitting first. Ring compounds such as benzene, cyclohexane, and methylcyclopentane do not markedly affect this conclusion, provided that the n-hexane content of Fig. 3 is expressed as a percentage of the C_6 paraffins in the feed.

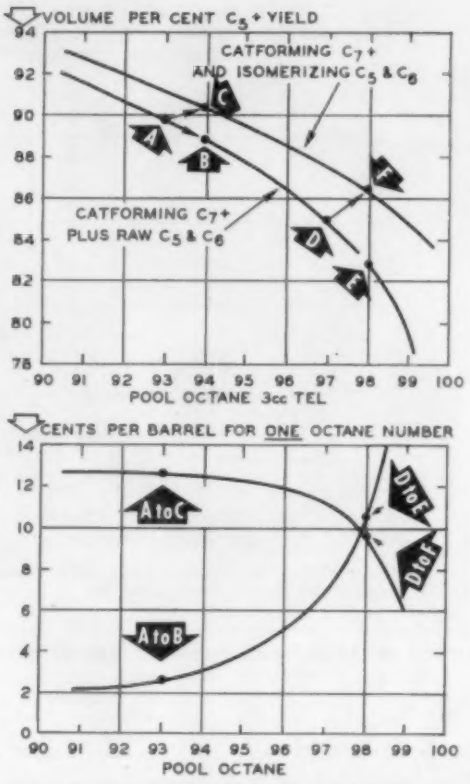
Ultimate Yields

In most cases, pentanes will be processed in a recycle operation to a 99 to 100 per cent yield at 95 per cent isopentane.

Typical over-all yields, R.v.p. change, and octane improvement for C_6 Pentafining are shown in Table 2. The Mid-Continent paraffinic C_6 fraction was processed once-through without splitting because of the high percentage of n-hexane. The product octane and yield are relatively low, but the octane-number improvement is 13.8 with the addition of 3 ml. TEL per gal. The other two stocks were


RELATIVE CENTS PER BARREL FOR ONE OCTANE NUMBER
WITHOUT SPLITTING
WITH SPLITTING
NORMAL HEXANE IN CHARGE, VOLUME PER CENT

RELATIVE COSTS of octane gain with and without pre-fractionation of C_6 charge to Pentafining as a function of n-hexane content of C_6 paraffins in feed. Fig. 3.



UPPER CHART gives field-octane comparison for combined Pentafining-Catforming and Catforming alone. Lower chart gives comparative costs in cents per barrel for octane as a function of total pool-octane level, combined Pentafining-Catforming, and Catforming alone. Fig. 4.

split before Pentafining because of their lower n-hexane contents.

When Does Pentafining Become Attractive?

With this basic information, it is possible to evaluate Pentafining to determine whether isomerization of C_5 and/or C_6 paraffins can be economically justified in a given refinery situation. We have made calculations for our own refinery and for several independent refiners.

Example . . . The conclusions reached in each study are similar, and they may be summarized with this example. Consider a refinery running 30,000 bbl. per day of Iraq crude oil with the C_7 to 380° F. fraction of straightrun naphtha going to a catalytic reforming unit, and the C_5 and C_6 light naphtha going directly to finished gasoline after caustic washing. If an increase in gasoline pool octane is required, one may increase the severity of catalytic reforming. Another possibility is to isomerize the C_5's and C_6's before blending them back into the gasoline pool, as indicated schematically in Fig. 6.

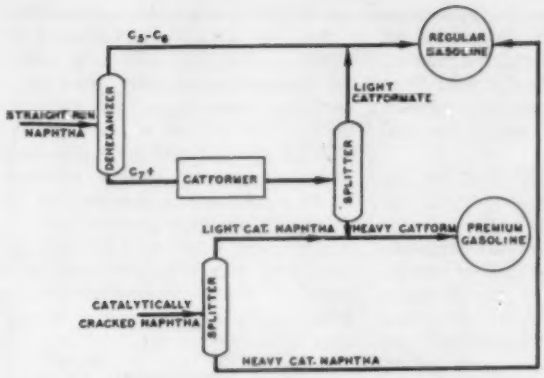
The yield of debutanized gasoline and the final octane levels are shown at the top of Fig. 4 for the two cases. The lower line is the yield-octane relationship achieved by Catforming the C_7 to 380° F. fraction from Iraq crude oil and blending back the raw C_5's and C_6's, while the upper line represents the final blend of the same Catformate with the Pentafined C_5 and C_6 streams.

Pool octane . . . If the present pool octane number is 93 with the addition of 3 ml. TEL per gal., and it is desired to produce a pool with a 94 research octane number, one can go from A to B by increasing severity or from A to C by installing and operating the isomerization facilities. Similarly, if the pool is to be increased from 97 to 98 octane, one could increase reforming severity from D to E or move from D to F with isomerization. In moving from D to F there is a yield advantage of 1.5 per cent of the total feed, as well as a credit for Catforming catalyst cost because of the lower reforming severity required. These credits (which are higher at the higher octane level) must be balanced against the operating and investment costs for the Pentafiner.

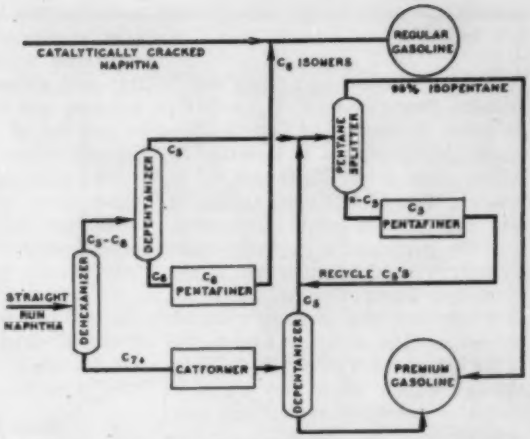
The calculations were made over

TABLE 2—YIELDS AND OCTANE IMPROVEMENT FROM C_6 ISOMERIZATION

	Mid-Continent		Middle East
	Paraffinic	Naphthenic	
C_6 charge:			
A.S.T.M. octane number (D 908, research method):			
Without TEL addition	46.8	66.6	59.8
With addition of 3 ml. TEL per gal.	78.0	89.4	85.6
R.v.p., lb.	5.2	5.2	5.4
C_6 product:			
A.S.T.M. octane number (D 908, research method):			
Without TEL addition	70.4	76.2	73.3
With addition of 3 ml. TEL per gal.	91.8	95.0	93.3
R.v.p., lb.	6.1	5.6	5.9
Charge, per cent by volume	94.3	97.3	96.5



PROCESS FLOW DIAGRAM of method for producing premium and regular gasolines by selective fractionation of catalytic reformate and catalytic-cracker gasoline. Fig. 5.



PROCESS FLOW DIAGRAM of combined Pentafining-Catforming integrated into over-all refinery operation. Fig. 6.

the entire octane range to determine the cost of getting one incremental octane number on the pool by both methods of processing, and the results are summarized in the lower half of Fig. 4. Gasoline-yield loss to butane and lighter was valued at 7 cents per gallon differential. The Pentafining investment, which included the pentane splitter, depentanizers, dehexanizer, and all auxiliary equipment, was written off over a 4-year period. Operating costs include utilities, catalysts, maintenance, labor, and royalty.

Higher severity . . . The cost of one incremental octane number by moving from point A to point B (higher reforming severity) is 3 cents per barrel, as compared to more than 12 cents per barrel by going from A to C with isomerization. The cost of one incremental octane number at higher levels, however, shows that it is desirable to include isomerization facilities and take the D to F route rather than from D to E with increased reforming severity alone. In this case, to reach a pool research octane number of 97.8, it becomes economical to meet the specifications by the combination of Catforming and Pentafining.

Today many refineries are approximately one-half to one octane below the crossover point in sendout pool octane. At that level it costs an extra 3 to 6 cents per barrel for octane for isomerization over reforming alone. However, as octane levels move up slightly, one can readily justify paraffin isomerization; and when the octane requirement gets only one-half octane above the crossover point, it is extremely uneconomical to rely on high-severity catalytic reforming alone. Inasmuch as an increase of less than one octane in the gasoline pool can affect the economics so substantially, it is important to properly study the problem and plan well in advance.

Comparison of Pentafining with Selective Blending

In the example just presented, the point at which Pentafining can be justified is 97.8 pool octane, which corresponds to an octane number of approximately 100 with the addition of 3 ml. per gallon for the Catformate product before blending with the C_5 and C_6 streams.

To distinguish between total refinery pool octanes and sendout octanes for regular and premium gasolines, two processing schemes have been studied to reach a 101-octane premium fuel—Case 1 without Pentafining and Case 2 with Pentafining. The refinery naphtha streams for gasoline blending consist of the 100-octane debutanized Catformate, the C_5 and C_6 stream from crude oil, and the debutanized catalytically cracked naphtha, as shown below in Table 3.

Selective fractionation . . . A block diagram for Case 1 is shown in Fig. 5. This scheme, which is used in Atlantic's own refineries, concentrates the high-octane components in the premium gasoline.

In this example the Catformate is fractionated into an aromatic-rich bottoms with a 102 research octane-number blending value and a light Catformate with a 96.3 octane-number rating. Then the cat naphtha is also fractionated into overhead and bottoms cuts with the light cat naphtha being 2 to 3 octanes higher than the bottoms.

By blending the high-octane Catformate bottoms and the high-octane cat naphtha overhead, a premium gasoline is obtained with good volatility properties and with a CFR extension octane number of 101, higher than either of the starting components. The regular gasoline contains the Catformate overhead and the heavy cat

TABLE 3—INSPECTIONS OF STOCKS AVAILABLE FOR PROCESSING AND BLENDING

	Pentane from crude oil	Hexane from crude oil	C_7 to 380°F. straightrun naphtha	Debutanized catformate from C_7 to 380°F. straightrun naphtha	Debutanized catalytically cracked naphtha
Barrels per day	1,050	900	7,350	5,880	6,000
A.S.T.M. octane No. (D 908, research method):					
Without TEL addition	77.3	54.0	40.6	92.4	92.3
With addition of 3 ml. TEL per gal.	94.0	82.1	....	100.0	98.0
R.v.p., lb.	....	5.7	0.8	4.3	4.1
A.S.T.M. distillation, °F.:					
I.b.p.	....	....	196	125	114
10 per cent point	....	....	220	174	150
30 per cent point	....	....	255	225	205
50 per cent point	....	....	283	267	254
70 per cent point	....	....	310	305	296
90 per cent point	....	....	342	347	360
E.p.	....	....	382	395	402

naphtha, as well as the straightrun C_5's and C_6's.

Pentafining-Catforming . . . Case 2 includes Pentafining of C_5 and C_6 paraffins, as shown in Fig. 6. The straightrun naphtha is dehexanized before going to the Catformer, as in Case 1. The Catformate product is also depentanized after stabilization, and the combined C_5's from crude oil and from Catformate go to the Pentafiner where they are converted to 95 per cent isopentane in a recycle operation. The hexanes from the crude oil go to a very simple once-through reactor where they are isomerized to essentially equilibrium composition.

The depentanized Catformate and the 95 per cent isopentane make up the premium gasoline pool. In these calculations, an octane number of 103.0 for 95 per cent isopentane with the addition of 3 ml. TEL per gallon has been used. Although higher values have been reported in the literature, Atlantic data show that 103.0 is a better blending value in high-octane components. The regular gasoline consists of the total cat naphtha and the hexane product.

Blend comparison . . . To compare the two cases, all of these blends have been made at constant reforming severity, with maximum TEL, and to a constant yield and research octane number of the premium gasoline. The variation occurs in the regular. The composition and properties of each blend are listed in Table 4.

There is a small difference in total gasoline yield between Case 1 and Case 2. This difference results from the very slight cracking losses that occur during C_5 and C_6 isomerization and from the increase in vapor pressure associated with converting an n-paraffin to an isomer. As shown, the yield difference that results from cracking and vapor-pressure increase is only 0.6 of 1 per cent of the total gasoline volume.

The volatility properties of the gasolines are approximately equal for both cases. Inasmuch as the research octane numbers have been held constant for the premium, all of the octane increase from isomerization shows up in the regular blends. Case 2 regular octane is 97.1 research octane number, and Case 1 regular octane is 94.7 research octane number.

Road Octane Ratings

However, the road-octane ratings are quite different from the research ratings. Although both premium mixtures rated iso+ 0.09 on the research scale, the Modified Uniontown road ratings show that the blend containing only Catformate and isopentane is 3.2 octane numbers higher than the blend of Catformate bottoms and cat naphtha overhead.

The road ratings are three car averages from Cadillac, Lincoln, and Buick. Essentially what has been done is that the components with high road ratings have been concentrated in the premium fuel. Although there is not complete agreement on the evaluation of road octanes, it is true that road octanes best indicate the performance of the fuel in an automobile. If we assume the cost of 1 octane at the 100+ level is 12 cents per barrel, the 3.2 octane-number advantage achieved is worth 38.4 cents per barrel. Of course, the loss of some road octane in the regular pool must be taken into account, but at the lower octane level, the cost per barrel for one octane is apparently some lower.

Another method of evaluating the higher road-octane rating is to reduce the Catforming severity in Case 2 until the premium pool has the same road octane as Case 1 premium, and then to calculate the yield advantage and catalyst cost savings obtained. At 99.3 road octane number, the 10-lb. R.v.p. premium-gasoline yield increases from 7,290 to 7,883 bbl. per day. This higher yield (valued at 7 cents per gallon differential) and the lower operating costs give a net savings of $2,199 per day.

Summary

Pentafining is a valuable processing tool for producing the high octanes that are required and will be required tomorrow. Up to a certain octane level, which is different for every refiner, the cost for octane improvement by paraffin isomerization is high. However, a small increase in pool-octane demand changes the economics considerably; and above the breakeven point, Pentafining represents a large savings over the other processing schemes.

The production of isopentane not only offers the refiner an excellent means of meeting research octane-number requirements, but it gives him a superb component with very high road antiknock properties for super-premium fuels.

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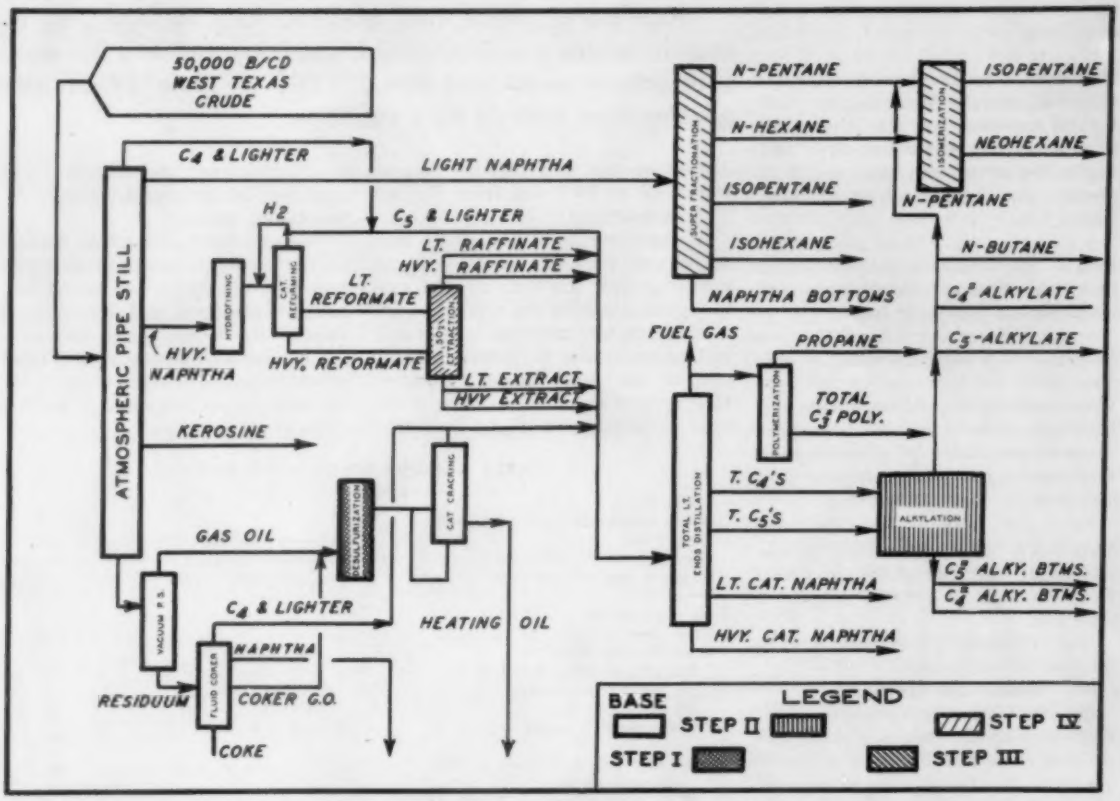
TABLE 4 — COMPARISON OF BLENDS

	Premium gasoline			
	Case 1		Case 2	
		Per cent		Per cent
	Catformate bottoms	52.2	Depentanized catformate	72.9
	Cat naphtha overhead	37.9	95 per cent isopentane	22.0
	Butane	9.9	Butane	5.1
Total barrels per day	7,290		7,290	
Reid vapor pressure, lb.	10.0		10.0	
Per cent at 212° F.	37.0		36.0	
A.S.T.M. octane number (D 908, research method):				
With addition of 3 ml. TEL per gal.	101.0 (iso + 0.09)		101.0 (iso + 0.09)	
Modified Uniontown road octane	99.3		102.5 (iso + 0.28)	

	Regular gasoline			
	Case 1		Case 2	
		Per cent		Per cent
	Catformate overhead	27.1	Total cat naphtha	79.4
	Cat naphtha bottoms	42.3	Isohexane stream	11.5
	C_5 and C_6 crude oil	25.5	Butane	9.1
	Butane	5.1		
Total barrels per day	7,650		7,650	
Reid vapor pressure, lb.	10.0		10.0	
Per cent at 212° F.	46.0		46.0	
A.S.T.M. octane number (D 908, research method):				
With addition of 3 ml. TEL per gal.	94.7		97.1	
Modified Uniontown road octane	95.5		96.1	



SIMPLIFIED FLOW DIAGRAM of future refinery showing four steps to make highest practicable octane gasoline pool: (1) increase cat-reform severity, (2) add alkylation, (3) add superfractionation to make isopentane and isohexane, and isomerization unit, and (4) add extraction unit to segregate aromatics from light and heavy reformate. Fig. 1.

110 Research Octane by 1960?

Here's a refinery view of fuels for the future

by S. P. Blumberg

RAPIDLY increasing engine compression ratios in new cars have been accompanied by a corresponding rise in octane quality of motor fuels. Extrapolations of current trends indicate that high-performance cars of 1960 will require a premium motor fuel of approximately 110 research octane number.

Stepwise addition of currently available commercial octane-improvement processes to an existing 50,000-bbl. per calendar day refinery will result in an upgrading of the research octane quality of the total gasoline pool from 98.0 to 102.5, and the research octane quality of the premium grade from 98 to 110.8.

This requires an added refinery investment of $18,000,000 and an increase in total investment of 40 per cent. The manufacturing costs of the premium grade were increased by 6.1 cents per gallon which represents an over-all octane-improvement cost of 19.9 cents per research octane-number barrel.

Basis for study . . . The study is based on a relatively small, new, and efficient refinery, constructed for the major purpose of producing increasingly higher octane-quality premium gasolines by the stepwise addition of established commercial octane-improvement processes.

The following assumptions were made concerning its operations: (1) that it would be an ultimate yield, inland refinery (away from tidewater) charging sour West Texas crude oil at a rate of 50,000 bbl. per calendar day, and (2) that in the base case the processing equipment would consist of a two-stage pipe still, a fluid catalytic cracking unit, a fluid coking unit, a Hydrofining unit, a regenerative naphtha catalytic reforming unit, a light-ends and catalytic naphtha distillation system, and a propylene catalytic polymerization unit.

Octane-improvement processes were added to the base refinery in four successive steps to manufacture the high-

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est practicable octane gasoline pool, as follows:

Step 1 . . . An increase in catalytic-reforming severity was made to yield a total reformate of 100 instead of 95 research octane number, clear, and a desulfurization unit was added to pretreat the total catalytic cracking gas-oil feed.

Step 2 . . . A sulfuric acid alkylation unit was added to process segregated butylene and pentylene feeds.

Step 3 . . . A superfractionation unit was added for fractionating the light virgin naphtha to yield isopentane and isohexane concentrates; an isomerization unit was added for processing the segregated n-pentane and hexane concentrates.

Step 4 . . . An extraction unit was added for segregating the aromatics from the light and heavy reformate fractions.

Fig. 1 presents a simplified flow diagram of the refinery.

Motor-Gasoline Blends

As the octane-improvement processes were added, there was an accompanying change in gasoline yield based on crude oil. To obtain a more realistic evaluation of the effects of increasing octane number, the entire refinery throughout and the processing capacities of individual units were adjusted so that the total gasoline production following installation of the facilities of each of the four steps was equal to that of the base case.

In addition, each gasoline pool was further adjusted to a constant 10-lb. Reid vapor pressure (R.v.p.) by either the removal of mixed butanes or the addition of purchased n-butane. Finally, each constant-R.v.p.-constant-volume gasoline pool was arbitrarily divided into premium and regular grades in 30:70 and 40:60 volume ratios by appropriate blending of the various refinery streams.

These ratios were selected to bracket the current 31:69 ratio of premium to regular-gasoline sales and an anticipated upward trend on this ratio as octane requirements increase in the future.

Gasoline characteristics . . . The octane and distillation characteristics of all the components produced in the various situations considered were known, and the corresponding values were calculated for the total pools. When the total pools were divided into 30 per cent premium and 70 per cent regular grades, the research and motor octane numbers of the regular pools were allowed to increase gradually from the base through Step 4 from 98.0 to 99.5 and from 86.0 to 87.5, respectively.

High-performance cars of 1960 may require 110 research octane. A 50,000-bbl. per day refinery to make such octane might cost $64,000,000 or some 39 per cent greater than today's base refinery.

In the division of the pools into 40 per cent premium and 60 per cent regular grades, the research and motor octane values of the regular grades were maintained constant at 98.0 and 86.0, respectively, to permit production of the same quality premium fuels as were produced with the 30:70 ratio of premium-to-regular fuel division. In all cases the volatility characteristics of the regular grades were maintained constant.

The volatilities and octane qualities of the total, premium, and regular fuels for the 30:70 and 40:60 divisions are presented in Tables 1 and 2, respectively. It was found that all of the regular and premium fuels represented practical blends which could be produced in the refinery facilities employed.

TABLE 1—GASOLINE-QUALITY DATA

Step No.—	Base	1	2	3	4
Gasoline volume, bbl. per calendar day:					
Total pool	←		29,729		→
Regular pool (70 per cent)	←		17,837		→
Premium pool (30 per cent)	←		11,892		→
Total pool quality:					
Reid vapor pressure, lb. (adjusted)	←		10		→
A.S.T.M. distillation, °F.:					
Per cent evaporated at 158° F.	30.1	32.9	30.6	34.0	32.2
50 per cent evaporated	201	196	209	213	217
90 per cent evaporated	344	334	331	332	350
Warmup-demerit rating	2.6	2.4	2.8	3.0	3.3
A.S.T.M.* octane number (D 908, research method):					
With the addition of 3 ml. TEL per gal.	98.2	99.4	100.5	102.2	102.5
A.S.T.M. octane number (D 357, motor method):					
With the addition of 3 ml. TEL per gal.	86.2	86.4	89.3	90.2	90.3
Sensitivity	12.8	12.6	11.2	12.0	12.2
Regular pool quality:					
Reid vapor pressure, lb.	←		10		→
A.S.T.M. distillation, °F.:					
Per cent evaporated at 158° F.	←		30		→
50 per cent evaporated	←		212		→
90 per cent evaporated	←		332		→
Warmup-demerit rating	←		3.0		→
A.S.T.M. octane number (D 908, research method):					
With the addition of 3 ml. TEL per gal.	98.0	98.5	99.0	99.5	99.5
A.S.T.M. octane number (D 357, motor method):					
With the addition of 3 ml. TEL per gal.	86.0	86.5	87.0	87.5	87.5
Sensitivity	←		12		→
Premium pool quality:					
Reid vapor pressure, lb.	←		10		→
A.S.T.M. distillation, °F.:					
Per cent evaporated at 158° F.	30.3	39.7	32.0	43.3	37.0
50 per cent evaporated	180	166	202	213	238
90 per cent evaporated	340	328	320	320	349
Warmup-demerit rating	2.0	1.5	2.4	2.8	4.2
A.S.T.M. octane number (D 908, research method):					
With the addition of 3 ml. TEL per gal.	98.0	102.4	105.4	109.4	110.8
A.S.T.M. octane number (D 357, motor method):					
With the addition of 3 ml. TEL per gal.	86.6	88.6	99.0	101.6	102.0
Sensitivity	11.4	13.8	6.4	7.8	8.8

*Octane numbers above 100 by the Wiese formula, octane number $= 100 + \frac{PN - 100}{3}$.

Volatility and octane qualities of the total, regular, and premium fuels for each of the steps shown in Table 2 are summarized as follows:

Pool and step—	R.v.p. (lb.)	Per cent evaporated at 158° F.	Warmup demerit	A.S.T.M.* octane number with the addition of 3 ml. TEL per gal. Research	Motor	Sensitivity
Total pool:						
Base	10	30	2.6	98.0	86.2	11.8
Step 4	10	32	3.3	102.5	90.3	12.2
Regular pool (60 per cent):						
All steps	10	30	3.0	98.0	86.0	12.0
Premium pool (40 per cent):						
Base	10	30	2.4	98.0	86.6	11.4
Step 4	10	36	3.7	110.8	104.3	6.5

*Octane numbers above 100 by the Wiese formula, octane number $= 100 + \frac{PN - 100}{3}$.

Octane increase . . . The cumulative effect of the octane-improvement processes is to upgrade the research octane number of the total pool from 98.0 to 102.5 and that of the premium pool from 98 to 110.8. The research octane number of the Step 4 premium grade is equivalent to the value forecasted for 12:1 compression-ratio cars.

As shown in the Table 2 summary, the warmup demerits for the premium fuels increased significantly in going from the base case to Step 4. Except for this, the study indicates that installation of currently available processes, coupled with operation at high-severity levels, may well answer the needs of the refiners to meet future required octane qualities up to this point.

In recent years, trends in engine design have resulted in an increase in the speed of knock, and motor octane ratings relative to research octane ratings have become greater factors in road-octane performance. As a result, it may become increasingly important to maintain the sensitivity of the gasolines at a value of 10 or less in the future.

As anticipated, premium-fuel sensitivity increased when reforming severity was increased (11.4 to 13.8; Step 1 over base), and then decreased significantly as alkylation was added. Sensitivity following Step 4 was only 6.5.

TABLE 2—GASOLINE-QUALITY DATA

Step No.—	Base	1	2	3	4
Gasoline volume bbl. per calendar day:					
Total pool	←		29,729		→
Regular pool (60 per cent)	←		17,837		→
Premium pool (40 per cent)	←		11,892		→
Total pool quality:					
Reid vapor pressure, lb. (adjusted)	←		10		→
A.S.T.M. distillation, °F.:					
Per cent evaporated at 158° F.	30.1	32.9	30.6	34.0	32.2
50 per cent evaporated	201	196	209	213	217
90 per cent evaporated	344	334	331	332	350
Warmup-demerit rating	2.6	2.4	2.8	3.0	3.3
A.S.T.M.* octane number (D 908, research method):					
With the addition of 3 ml. TEL per gal.	98.2	99.4	100.5	102.2	102.5
A.S.T.M. octane number (D 357, motor method):					
With the addition of 3 ml. TEL per gal.	86.2	86.4	89.3	90.2	90.3
Sensitivity	12.8	12.6	11.2	12.0	12.2
Regular pool quality:					
Reid vapor pressure, lb.	←		10		→
A.S.T.M. distillation, °F.:					
Per cent evaporated at 158° F.	←		30		→
50 per cent evaporated	←		212		→
90 per cent evaporated	←		332		→
Warmup-demerit rating	←		3.0		→
A.S.T.M. octane number (D 908, research method):					
With the addition of 3 ml. TEL per gal.	←		98		→
A.S.T.M. octane number (D 357, motor method):					
With the addition of 3 ml. TEL per gal.	←		86		→
Sensitivity	←		12		→
Premium pool quality:					
Reid vapor pressure, lb.	←		10		→
A.S.T.M. distillation, °F.:					
Per cent evaporated at 158° F.	30.3	37.3	31.5	40.0	35.5
50 per cent evaporated	193	184	206	213	228
90 per cent evaporated	342	330	325	325	348
Warmup-demerit rating	2.4	1.9	2.6	2.9	3.7
A.S.T.M. octane number (D 908, research method):					
With the addition of 3 ml. TEL per gal.	98.0	102.4	105.4	109.4	110.8
A.S.T.M. octane number (D 357, motor method):					
With the addition of 3 ml. TEL per gal.	86.6	88.6	98.0	103.5	104.3
Sensitivity	11.4	13.8	6.4	5.9	6.5

*Octane numbers above 100 by the Wiese formula, octane number $= 100 + \frac{PN - 100}{3}$.

Alkylate use . . . It should be emphasized that Step 4 represents utilization of a large amount of alkylate in motor gasoline relative to normal refinery practices. For example, the target research octane quality of 110 can be met without the use of alkylate, as shown in Table 3. In this case, the use of a large amount of aromatics resulted in the sensitivity of 10.0. On this basis it would be questionable for car manufacturers to rely upon a sensitivity of less than 10.

The vapor-lock and warmup characteristics of a fuel are known to be influenced by its R.v.p. and distillation characteristics. The vapor-locking tendencies of a fuel are often characterized by its vapor pressure and the percentage evaporated at 158° F. All of the fuels in Table 2 are reasonably similar and are satisfactory from the standpoint of vapor lock.

The warmup characteristics of a gasoline are controlled primarily by mid and backend volatilities. Moore, Young, and Toulmin have correlated warmup performance with ambient temperature and the 50 per cent and 90 per cent evaporation temperatures of the fuel.[1,2] This correlation was employed to obtain the warmup-demerit ratings shown in Tables 1, 2, 3, and 5.

Fuels with high 50 per cent and 90 per cent distillation temperatures ex-

TABLE 3—OCTANE-QUALITY DATA OF EXPERIMENTAL BLENDS

	Blend No. 1	Blend No. 2	Blend No. 3
Component composition, per cent by volume:			
Light isoparaffins (C_4, C_5, and C_6)	42	28	35
Mixed alkylate	20	20	
Purified aromatics (toluene, xylene, and C_9)	38	52	65
Inspection data:			
Reid vapor pressure, lb.	11.2	12.3	12.3
A.S.T.M. distillation, °F.:			
Per cent evaporated at 158° F.	18	23	25
50 per cent evaporated	242	238	217
90 per cent evaporated	300	300	302
Warmup-demerit rating	3.9	3.5	2.6
A.S.T.M.* octane number (D 908, research method):			
With the addition of 3 ml. TEL per gal.	105	107	110
A.S.T.M. octane number (D 357, motor method):			
With the addition of 3 ml. TEL per gal.	100	99	100
Sensitivity	5	8	10

*Octane numbers above 100 by the Wiese formula, octane number $= 100 + \frac{PN - 100}{3}$.

hibit poor warmup characteristics and, consequently, have the highest demerit ratings. It is important to note that the warmup-demerit rating of the premium fuels increased from 2.0 to 4.2 for the base case over Step 4 (Table 1) and from 2.4 to 3.7 for the base case over Step 4 (Table 2).

The rapid rise in demerit rating was experienced as the concentration of the high-boiling, high-octane alkylates and aromatics was increased. This emphasizes the fact that the warmup problem will likely gain in importance as the octane levels continue to rise.

Octane-Improvement Costs

It was estimated that the base refinery would cost $46,000,000, or approximately $920 per daily barrel of crude-oil charging capacity; this figure is believed to be within the range of costs of constructing such a refinery today. Estimates of investments for integrating the processing facilities for each successive step considered would be expected to vary substantially, depending upon the existing situation and the expected ultimate situation.

Accordingly, a single estimate was prepared, covering the cost of a new refinery containing all of the facilities through Step 4. This investment would be on the order of $64,000,000, which is some 39 per cent greater than that for the base refinery, for the same motor-gasoline production but of the higher octane quality.

Operating costs and product values were selected as being reasonably typical of the assumed situations. In order to obtain an indication of the cost of octane improvement, refinery realizations on all products except premium gasoline were held constant. Raw-stock costs, operating costs, and product values for the base case and for completion of Step 4 facilities are presented in Table 4.

The results presented in Table 2 and Table 4 for the base and Step 4 are summarized as follows:

	Base	Step 4
Premium gasolines:		
Qualities:		
A.S.T.M.* octane number (D 908, research method):		
With the addition of 3 ml. TEL per gal.	98.0	110.8
A.S.T.M.* octane number (D 357, motor method):		
With the addition of 3 ml. TEL per gal.	86.6	104.3
Manufacturing cost, cents per gal.	12.5	18.6
Octane-improvement costs:		
Research above base, cents per research octane-number bbl.		19.9
Motor above base, cents per motor octane-number bbl.		14.4

*Octane numbers above 100 by the Wiese formula, octane number $= 100 + \frac{PN - 100}{3}$.

The inclusion of all the improvement processes in Step 1 through Step 4 effected an increase in the research and motor octane numbers of 12.8 and 17.7, respectively, for an added cost of 6.1 cents per gal. This is equivalent to research octane-number barrel and motor octane-number barrel improvement costs of 19.9 cents and 14.4 cents, respectively.

The costs are not to be considered additive, inasmuch as each was calculated from the same difference (6.1 cents per gal.) in manufacturing cost. It can be observed in Table 2 that all of the added processes contributed almost equally to the rise in the research octane number of the premium pool; however, the motor octane increase was gained primarily through the use of alkylate.

If the sensitivity of a fuel continues to exhibit an important influence on its road-octane rating, refiners will continue to examine all processes from the standpoint of both types of octane-improvement costs. The study indicates that obtaining further increases in octane quality will

TABLE 4—MATERIAL BALANCE, ECONOMICS, AND INVESTMENTS

	Base			Step 4		
	Bbl. per calendar day	Cents per gallon	$ per calendar day	Bbl. per calendar day	Cents per gallon	$ per calendar day
Raw stocks and degration costs:						
Crude oil	50,000	7.26	152,500	45,165	7.26	137,753
n-Butane				1,272	5.00	2,671
Isobutane				2,102	8.00	7,062
Gas (or equivalent fuel)†	*3,104	†0.15	*2,794	*2,343	†0.15	*2,109
L.P.G. (C_3)	*1,369	3.50	*2,012	*1,328	3.50	*1,952
Mixed C_4's	*1,982	10.00	*8,324		10.00	
Kerosine	*7,300	7.50	*22,995	*7,651	7.50	*24,101
Heating oil	*7,544	7.00	*22,179	*7,524	7.00	*22,121
Coke‡	*966	‡11.00	*2,596	*900	‡11.00	*2,343
Gasoline, regular	*17,837	12.50	*93,644	*17,837	12.50	*93,644
Loss	2,024			936		
Gasoline, premium§	*11,892			*11,892		
Net costs¶	0		*2,044	0		1,216
Operating costs			39,191			56,504
Premium gasoline	11,892	12.50	62,432	11,892	18.52	92,745
Total investment, in millions of dollars			46			64

*Credits. †Fuel-gas value, at 15 cents per million B.t.u. ‡Coke value, at $11 per ton. §Costs established by difference, as shown previously. ¶Net costs or credits, excluding premium gasoline.

become much more difficult and considerably more expensive.

Aviation gasoline . . . Many refineries have commitments to supply aviation gasoline as well as two or more grades of motor gasoline. An analysis was made to determine the quality effect on the premium motor-gasoline pool, if sufficient components were first made available for the production of 10 per cent of Grade 115/145 aviation fuel. The remaining pool, after a readjustment to 10-lb. R.v.p., was then divided into 40 per cent premium and 60 per cent regular-grade motor fuels.

Table 5 presents the distillation and octane qualities obtained for Step 2, Step 3, and Step 4. These data may be compared with the data from Table 2 as follows:

Step No.—	Per cent					
	2		3		4	
Average gasoline sales—	0	10	0	10	0	10
Premium fuels:						
A.S.T.M.* octane number (D 908, research method):						
With the addition of 3 ml. TEL per gal.	105.4	103.6	109.4	107.0	110.8	108.3
A.S.T.M.* octane number (D 357, motor method):						
With the addition of 3 ml. TEL per gal.	99.0	94.6	103.5	97.3	104.3	97.7
Sensitivity	6.4	9.0	5.9	9.7	6.5	10.6
A.S.T.M. distillation, °F.:						
50 per cent evaporated	206	212	213	213	228	238

*Octane numbers above 100 by the Wiese formula, octane number $= 100 + \frac{PN - 100}{3}$.

TABLE 5—EFFECT OF PRODUCING 10 PER CENT AVIATION GASOLINE

Step No.—	2	3	4
Total gasoline-pool volume, bbl. per calendar day	←——29,729——		→
Regular	←——15,941——		→
Premium	←——10,628——		→
Aviation Grade 115/145	←——2,973——		→
Aviation Grade 115/145 quality:			
Reid vapor pressure, lb.	←—— 7 ——		→
A.S.T.M. distillation, °F.:			
Per cent evaporated at 158° F.	←—— 30 ——		→
50 per cent evaporated	←—— 205 ——		→
90 per cent evaporated	←—— 287 ——		→
Warmup-demerit rating	←—— 1.7 ——		→
A.S.T.M.* octane number (D 908, research method):			
With the addition of 3 ml. TEL per gal.	←—— 108 ——		→
A.S.T.M.* octane number (D 357, motor method):			
With the addition of 3 ml. TEL per gal.	←—— 102 ——		→
Sensitivity	←—— 6 ——		→
Regular pool quality†			
Premium pool quality:			
Reid vapor pressure, lb.	←—— 10 ——		→
A.S.T.M. distillation, °F.:			
Per cent evaporated at 158° F.	29.9	33.6	31.6
50 per cent evaporated	212	213	238
90 per cent evaporated	300	295	357
Warmup-demerit rating	2.4	2.3	3.6
A.S.T.M.* octane number (D 908, research method):			
With the addition of 3 ml. TEL per gal.	103.6	107.0	108.3
A.S.T.M.* octane number (D 357, motor method):			
With the addition of 3 ml. TEL per gal.	94.6	97.3	97.7
Sensitivity	9.0	9.7	10.6

*Octane numbers above 100 by the Wiese formula, octane number $= 100 + \frac{PN - 100}{3}$.

†The same quality as shown in Table 2.

TABLE 6—EFFECT OF THREE-GRADE-SYSTEM GASOLINE MARKETING

	Per cent by volume of total pool	With the addition of 3 ml. TEL per gal. A.S.T.M.* octane number (D 908 research method)	With the addition of 3 ml. TEL per gal. A.S.T.M.* octane number (D 357 motor method)	R.v.p. (lb.)
Three-grade—Step 2:				
First grade	15	110.8	101	10
Second grade	35	102.4	89	10
Third grade	50	98.0	86	10
Two-grade—Step 4:				
Premium	40	110.8	104.3	10
Regular	60	98.0	86.0	10

*Octane numbers above 100 by the Wiese formula, octane number $= 100 + \frac{PN - 100}{3}$.

As would be expected, losses in research octane (1.8 to 2.5), motor octane (4.4 to 6.6), and midvolatility (6° to 10° F.) and substantial increases in sensitivity (2.6 to 4.1) occurred when alkylate was removed to produce aviation fuel. These data serve to emphasize again that future premium gasolines may well have sensitivities above 10, if the production of aviation gasoline remains at substantial levels.

Three-grade system . . . A number of gasoline manufacturers are currently marketing three grades of motor fuel while others are continuing to market only two grades. To show the effect of employing a three-grade system, the total gasoline pool of Step 2 was divided into three grades according to the percentage figures shown in Table 6.

The research octane numbers of the first and third grades were fixed, and the second grade was then calculated by the difference. The research octane number of the first and third-grade fuels purposely were selected to be identical to the premium and regular grades of Step 4 in Table 2.

It should be noted that by dividing the Step 2 pool into three grades, a manufacturer could satisfy essentially the same percentage of high and low-compression-ratio cars as the two-grade system of Step 4, without a substantial additional refinery investment for facilities such as isomerization and extraction of catalytic reformates.

Acknowledgment

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Upgrading the C_5 and C_6 Paraffins

. . . by the Penex process for hydroisomerization

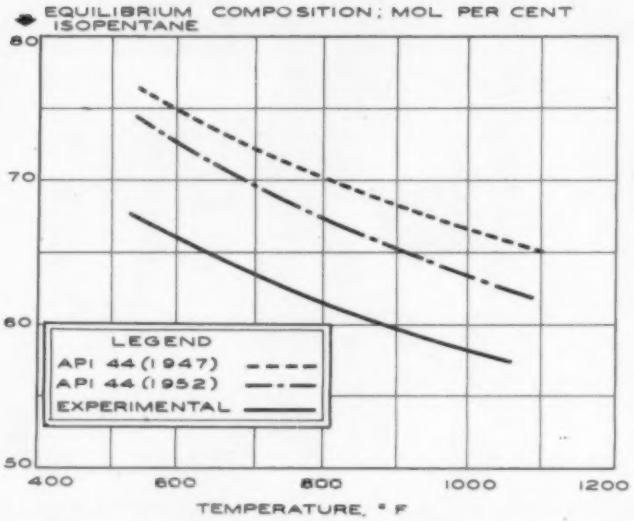
- **Catalyst replacement costs are sharply reduced**
- **Plant corrosion problems are essentially eliminated**

by D. H. Belden,* V. Haensel,* W. G. Starnes,† and R. C. Zabor†

BY 1960 the C_5 and C_6 paraffins from crude oil and natural gasoline will amount to more than 1,000,000 bbl. per day in the United States and will compose 20 per cent of the total motor-gasoline pool (Table 1). A substantial improvement in their quality by isomerization will markedly affect the over-all octane-barrel picture.

The Penex process for n-pentane hydroisomerization operates at a high conversion per pass, with 55 to 60 per cent of isopentane appearing in the reactor effluent at a volumetric reaction efficiency of over 99 per cent.

A plant which processes 2,000 bbl. per stream day of 93-leaded-octane-number feed containing 40 per cent of isopentane costs approximately $800,000, and it produces 1,985 bbl. per stream day of product containing 95 per cent of isopentane and having a leaded octane number of 105.



EQUILIBRIUM COMPOSITION of the n-pentane and isopentane system. Fig. 1.

Hexanes . . . Isomerization of hexane fractions by the Penex process is complicated by the larger number of paraffin types and the presence of cyclics in most commercially prepared C_6 fractions.

Nevertheless, a considerable upgrading of C_6 fractions is achieved by once-through processing. A boost of 10 to 13 leaded numbers can be expected from such an operation, with volumetric yields of 97 to 98 per cent.

By the application of partial or total recycle operation, through the use of fractionation, to separate the less desirable compounds from those of high quality, it is possible to achieve a boost of 15 to 20 octane numbers.

For selected cases, economies can be effected by simultaneous processing the C_5 and C_6 fractions, although slightly lower over-all yields are obtained because operating conditions are not maintained at optimum values for each of the two classes of materials present.

Indicative of the importance with which this development is being viewed by refiners is the fact that a number of Penex units, ranging in capacity from 2,000 to 35,000 bbl. per day of reactor charge, are in various stages of design and construction.

Several processes studied . . . As a result of the potential importance of the upgrading of these fractions, numerous processing methods were initially considered. These included aromatization, dehydrogenation to olefins,

*Universal Oil Products Co., Des Plaines, Ill., and †Gulf Research & Development Co., Pittsburgh. Paper presented at a session on Isomerization and Reforming during the midyear meeting of the American Petroleum Institute's Division of Refining, Philadelphia, May 16, under the original title, "Hydroisomerization by the Penex Process."

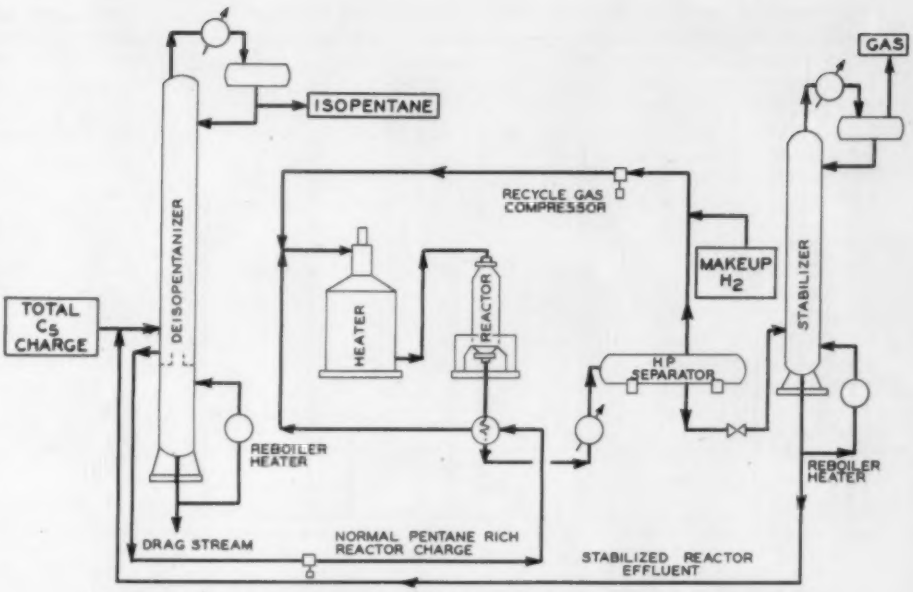
TABLE 1—POTENTIAL C_5 AND C_6 PARAFFINS AVAILABLE FROM CRUDE OIL AND NATURAL GASOLINE (ESTIMATED FOR 1960)

	Barrels per day		
	United States	Rest of Free World	Total Free World
Crude-oil consumption	10,300,000	8,400,000	18,700,000
Natural-gasoline consumption	960,000	200,000	1,160,000
C_5 and C_6 paraffins from crude oil (5.5 per cent)	565,000	460,000	1,025,000
C_5 and C_6 paraffins from natural gasoline (60 per cent)	575,000	120,000	695,000
Total virgin C_5 and C_6 paraffins	1,140,000	580,000	1,720,000
C_5 and C_6 fractions from catalytic reforming	280,000	230,000	510,000

and isomerization to isoparaffins. Because of their low molecular weight, these C_5 and C_6 paraffins are not amenable to upgrading by aromatization. Octane-number improvement of these paraffins can be achieved by dehydrogenation to olefins; however, process studies of this method indicate that high yield losses and frequent regenerations are encountered.

In addition, the use of this processing method would depreciate the road rating, lower the lead susceptibility, and add to the instability of the gasoline pool by increasing its olefine content. On the other hand, isomerization of the sraight-chain components of these fractions is an ideal mechanism for upgrading. Isomerization increases the research octane number, improves the road performance, and augments the stability of the gasoline pool.

Hydroisomerization, i.e., isomerization in the presence of hydrogen with solid, dual-function catalysts, is an ideal method of achieving the upgrading of the C_5 and C_6 paraffins. Maintenance of a hydrogen atmosphere in the presence of the hydrogenation components of such catalysts insures long catalyst life. Such operation eliminates polymer and sludge formation which plays an important role in deactivation of other catalyst systems.



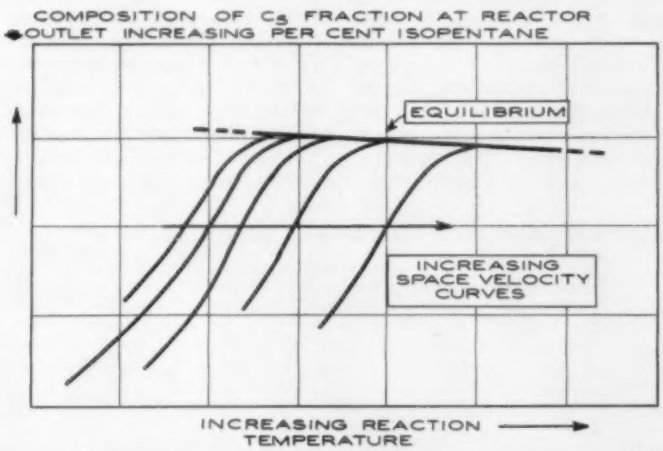
PROCESS FLOW for the Penex process is shown in this simplified diagram. **Fig. 3.**

As a result of this long life, catalyst replacement costs are drastically reduced. Furthermore, plant corrosion problems and the accompanying high maintenance costs are essentially eliminated by this technique.

Equilibrium picture . . . Because isomerization involves principally only one reaction path, it is important to establish the prevailing equilibrium picture. In this way it is possible to determine the ultimate conversion to the desired isomers which can be obtained in each pass through the reaction zone. Fig. 1 gives the experimental equilibrium composition of isopentane and n-pentane at various reaction temperatures.

In the region of commercial interest, isopentane contents of 60 to 64 per cent can be expected. Fig. 1 also compares the experimental results with both the 1947 and 1952 A.P.I. Project 44 data, plotted on a neopentane-free basis and derived from thermodynamic properties The experimental isopentane content at equilibrium is 5 to 7 per cent below that of the more recent A.P.I. figures.

It should be mentioned that neopentane is absent in the reaction products; this is consistent with established mechanisms for the isomerization reaction. Equilibrium limited conversions and similar deviations from the thermodynamically predicted equilibrium distribution have also been observed experimentally in the n-hexane-isohexane system.

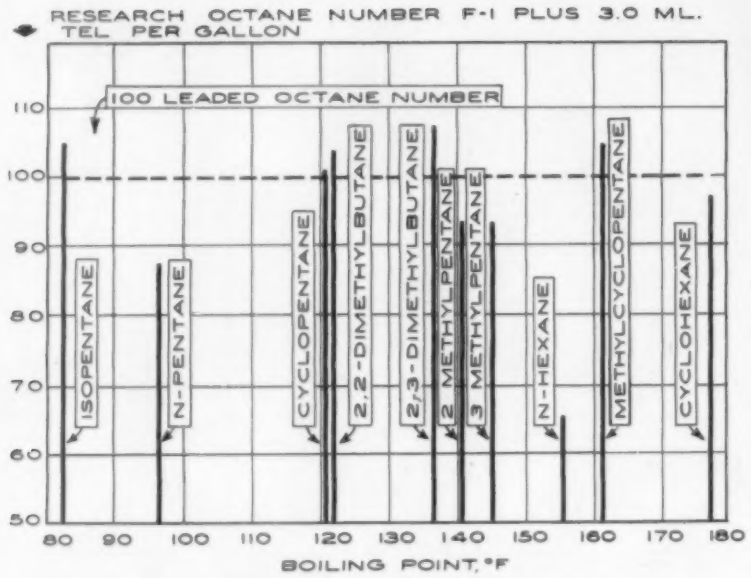

COMPOSITION OF C_5 FRACTION AT REACTOR OUTLET INCREASING PER CENT ISOPENTANE
EQUILIBRIUM
INCREASING SPACE VELOCITY CURVES
INCREASING REACTION TEMPERATURE

PROCESS VARIABLE CORRELATION of temperature, space velocity, product isopentane concentration, and equilibrium relationships. **Fig. 2.**

High conversions . . . Because of the equilibrium conditions which prevail for C_5 and C_6 isomerization, complete conversion to the desired isomers cannot be accomplished in a single pass. Where maximum upgrading of the C_5 and C_6 fractions is desired, fractionation must be used to obtain lower-boiling, high-quality isomers for gasoline blending and to provide higher-boiling low-quality isomers for recycle to the hydroisomerization reactor.

Inasmuch as the fractionation equipment is a major element in plant and operating costs, the amount of material to be processed under recycle operation must be minimized, making it essential to operate at the highest possible conversion per pass.

To accomplish this aim requires the selection of operating conditions and a catalyst which result in the following: (1) a high activity, to permit equi-



OCTANE NUMBERS and boiling points of the C_5 and C_6 hydrocarbons. Fig. 4.

librium conversions at lower temperatures where the equilibrium is more favorable; (2) a high selectivity at these high conversion levels, so that yield losses are not encountered; and (3) long catalyst life, to permit continuous operation for extended periods of time.

Process possibilities . . . In the Penex process, equilibrium conversion of straight to branched chain paraffins can be obtained at temperatures several hundred degrees lower than those used in catalytic reforming, and at liquid velocities as high as 50 volumes of charge per hour per volume of catalyst.

The experimentally derived relationship between space velocity, temperature, and conversion is shown in Fig. 2. From these data it is possible to adjust the space velocity so as to give the maximum yield of desired products in an acceptable range of operating temperature. That the process is selective is indicated by the fact that efficiencies of 97 to 99 per cent (depending on the charge stock) can be obtained.

That long catalyst life can be achieved has been assured by providing the proper hydrogen-hydrocarbon atmosphere and the catalytic ingredients which efficiently prevent the formation of high-boiling deposits and coke precursors. In this way, long life at substantially constant activity levels can be expected commercially, and has been obtained in bench-scale and pilot-plant aging studies.

TABLE 2—C_5 PENEX HYDROCARBON YIELDS AND HYDROCARBON REQUIREMENTS

Hydrogen consumption based on reactor feed, std. cu. ft. per bbl.:	
Chemical loss	10
Solution loss	30
Total	40
C_4 and lighter gas composition, std. cu. ft. per bbl. on reactor feed:	
Methane	5
Ethane	4
Propane	5
Butane	7
Total	21
Isopentane production, per cent by volume of n-pentane consumed	99
Reaction efficiency, mole per cent	98

Although commercial interest is primarily centered on the upgrading of C_5 and C_6 fractions, similar results are obtained when the hydroisomerization technique is applied to C_4, C_7, and higher-boiling fractions.

Pentane Isomerization

Pentane hydroisomerization usually involves processing at only one severity level. This level corresponds to that combination which results in a close approach to isomerization equilibrium without appreciable side reactions.

The investment and operating costs are low. Low hydrogen-hydrocarbon ratio results in a comparatively small cost for gas compression and circulation, low temperatures permit the substitution of less costly alloy equipment, and the high space velocity means a smaller investment in catalyst inventory.

By applying the experience gained from the operation of Platformers to the hydroisomerization process, and by confirming these predictions with extensive laboratory and pilot-plant investigations, it is expected that Penex catalyst will have an extremely long life. In the case of pentane isomerization, catalyst life well in excess of 100 bbl. of reactor feed per pound of catalyst is anticipated.

High yields . . . Table 2 shows the expected yields. The hydrogen consumption comprises mainly the amount required to satisfy solution losses which occur in the high-pressure receiver. It is noteworthy that the process is extremely efficient in its conversion of n-pentane to isopentane, in that a volumetric yield of 99 per cent, based on the n-pentane consumed, can be expected.

Shown in Table 3 is a yield summary for a C_5 Penex unit charging 2,000 bbl. per day of total fresh feed. In this example the 2,000-bbl. per day fresh-feed stream with an isopentane content of 40 per cent is converted to 1,985 bbl. per day of product containing 95 per cent of isopentane, with an equivalent pentane loss to light products of only 15 bbl. per day.

For gasoline purposes, the fraction

TABLE 3—C_5 PENEX TYPICAL COMPOSITION OF PRODUCT STREAM

Components, bbl. per day:	Net fresh feed	Deisopentanizer: Column feed	Deisopentanizer: Overhead product	Deisopentanizer: Bottoms to reactor	Reactor separator liquid	Stabilizer bottoms
C_4 and lighter (pentane equivalent)	...	...	...	...	15	...
Isopentane	800	2,090	1,885	205	1,290	1,290
n-Pentane	1,200	2,175	100	2,075	975	975
Total	2,000	4,265	1,985	2,280	2,280	2,265
Isopentane content, per cent by volume	40.0	49.0	95.0	9.0	56.6	57.0
A.S.T.M. octane number (D 908, Research method), with addition of 3 ml. TEL per gal.	93	...	105	...	...	...

has been upgraded from 93 to 105 leaded research octane number.

Flow pattern . . . A simplified flow diagram for a C_5 Penex unit is shown in Fig. 3. The n-pentane concentrate in admixture with hydrogen is heated and charged to the hydroisomerization reactor. The reactor effluent, after heat exchange, enters a separator from which the hydrogen is removed and recycled. The liquid product is then stabilized for rejection of a small amount of butane and lighter products as well as dissolved hydrogen.

The stabilized liquid, containing close to an equilibrium concentration of isopentane (55 to 60 per cent), is fed back to the deisopentanizer for separation into the desired 95 per cent isopentane product and unconverted n-pentane.

It is important to point out that most virgin C_5 fractions contain 35 to 45 per cent of isopentane. Inasmuch as equilibrium considerations limit the reactor effluent to an isopentane content of approximately 60 per cent, once-through processing without at least deisopentanization of the virgin pentane fraction will effect only a minor boost in the octane number of the final blended product stream.

In addition, the refinery pentane feed stock may contain impurities which, in some cases, will require that special provisions be made for their control or elimination for optimum isomerization results. For example, a drag stream can be removed from the bottom of the deisopentanizer to minimize the accumulation of C_6 and heavier hydrocarbons which may be present in the feed.

TABLE 4—C_5 PENEX OPERATING AND INVESTMENT COSTS

	Dollars per day	Cents per bbl.
Basis, bbl. per day:		
Net fresh feed (40 per cent of isopentane)	2,000	
Reactor combined feed	2,280	
Isopentane product (95 per cent)	1,985	
Operating costs:*		
Labor and supervision	85	4.3
Utilities	350	17.5
Maintenance, taxes, and insurance	125	6.2
Catalyst replacement	40	2.0
Total	600	30.0
Investment cost, erected†	$820,000 ($410 per bbl.)	

*Exclusive of royalty. †Exclusive of catalyst charge.

Costs . . . The estimated operating and investment costs for a C_5 Penex unit processing 2,000 bbl. per day of total fresh feed (40 per cent of isopentane) are summarized in Table 4. The utility costs are based on rates typical of the Gulf Coast area. Total operating costs amount to 30 cents per barrel of fresh feed processed, and the investment cost is approximately $400 per barrel for units at this capacity level.

This is very attractive when it is appreciated that the total pentane feed has been upgraded approximately 12 leaded research octane numbers, at a liquid yield of 99 per cent.

Hexane Isomerization

In the case of hexane isomerization the octane number of the product stream is intimately related to the extent of recycle and fractionation facilities which are provided. The virgin hexane fractions which would be available from commercial fractionation equipment will contain from 10 to 20 per cent of C_6 cyclics. Under the conditions at which isomerization is carried out, these cyclic compounds will not be appreciably altered.

Table 5 gives analyses of a number of hexane fractions derived from domestic and foreign sources. The high-octane-number dimethylbutane isomers are present in low concentrations, usually less than 10 per cent. The n-hexane content shows variations from 23 to 44 per cent, which is reflected in the octane number of the total fraction.

Fig. 4 shows the relationship which exists between the normal boiling points of the C_5 and C_6 paraffins and naphthenes and their leaded research octane numbers. Clearly illustrated is the need for maximizing the production of the 2,2-dimethylbutane and 2,3-dimethylbutane, at the expense of n-hexane and some of the methylpentanes, if the product is to have leaded octane numbers in the vicinity of 100.

The proximity of the boiling points of 2,3-dimethylbutane and the methylpentanes indicates the necessity for good fractionation facilities to obtain an effective separation of these compounds. It is also significant that the boiling points of methylcyclopentane and n-hexane are close; thus, in a recycle operation, good fractionation is required to remove C_6 cyclics from the reactor feed.

Because cyclic hydrocarbons have high octane numbers, their inclusion directly in the final product causes no deterioration in product quality.

Flow patterns . . . In Fig. 5 are presented three types of flows which might be utilized in the processing of hexane fractions. The selection of the one to be used in a particular situation will, of course, be dictated by the extent of upgrading which can be economically justified.

The simplest case is illustrated in Fig. 5a wherein a hexane feed with an 81 leaded octane number is processed through a C_6 Penex reactor section and stabilized to reject the C_4

TABLE 5—TYPICAL ANALYSES OF C_6 FRACTIONS (104° TO 165° F.)

Components, per cent by volume:	Barninus	Pennsylvania	South Louisiana	Gulf Coast	Oklahoma	Wyoming	Arabian	Natural gasoline, Texas	Natural gasoline, Texas
Cyclopentane	5	2	2	3	3	4	2	2	5
2,2-Dimethylbutane	Trace	3	2	3	1	1	1	2	3
2,3-Dimethylbutane	5	5	5	5	2	3	3	4	6
2-Methylpentane	20	27	25	25	22	22	22	28	28
3-Methylpentane	19	18	18	20	15	14	16	17	15
n-Hexane	32	37	31	30	40	35	44	34	23
Methylcyclopentane	16	6	14	3	14	18	7	9	14
Dimethylpentanes	Trace	Trace	1	1	...	1	1	Trace	Trace
Cyclohexane	1	Trace	1	7	1	1	2	1	2
Benzene	2	2	1	3	2	1	2	3	4
Total	100	100	100	100	100	100	100	100	100
C_6 cyclics, per cent by volume	19	8	16	13	17	20	11	13	20
A.S.T.M. octane number (D 908, Research method), with addition of 3 ml. TEL per gal.	88	86	...	90	...	86	82	86	92

and lighter hydrocracked products, to yield an isomerized fraction with a 91 leaded octane number.

The basic case in Fig. 5b is similar to that in Fig. 5a, except for the fact that a deisohexanizer column has been inserted in the total feed stream in order to bypass the naturally occurring high-octane-number isomers present in the fresh feed around the reactor section. Such a scheme will yield a product of approximately 94 leaded octane number.

If a further lift in octane number is desired, some recycling of the stabilizer bottoms product of approximately 91 research leaded octane number can be used to give an overall product blend of 96 research leaded octane number. In this instance, because total recycle is not involved, the C_6 cyclic content of the combined feed is kept from accumulating in the recycle circuit by bleeding off a portion of the stabilizer bottoms directly into total product.

Fig. 5c represents the case in which a total product of 100 leaded octane number is obtained through the utilization of total recycle operation. In this instance, facilities are provided for the preferential rejection of the C_6 cyclic hydrocarbons in the fresh feed from the bottom of the dehexanizer.

Properly fractionated, this stream will not impose a degrading effect on the quality of the total blended product since cyclic concentrates, reasonably low in n-hexane, have acceptably high octane numbers.

It should be pointed out that both the dehexanizer and deisohexanizer columns are making extremely difficult separations and, therefore, must be equipped with an adequate number of trays and reflux facilities.

TABLE 6—C_6 PENEX HYDROCARBON YIELDS AND HYDROGEN REQUIREMENTS

Hydrogen consumption based on reactor feed, std. cu. ft. per bbl.:	
Chemical loss	25
Solution loss	25
Total	50
C_4 and lighter gas composition, std. cu. ft. per bbl.:	
Methane	4
Ethane	9
Propane	18
Butane	15
Total	46
Liquid yield per reactor pass, per cent by volume	97.7

Equilibrium . . . As in the case of C_5, the C_6 isomer distribution is governed by equilibrium considerations such that the paraffinic portion of the reactor effluent will have essentially the same distribution, and hence the same octane number, regardless of the quality of the reactor feed.

Thus, to achieve greatest upgrading of the C_6 fraction, one is faced with the necessity of removing the choice materials from the reactor feed before processing over the catalyst, as shown in Fig. 5b and 5c.

Hydrogen requirements in C_6 Penex are approximately the same as for C_5 processing, as indicated in Table 6. The liquid volume yield of C_6 and heavier reactor effluent is 97 to 98 per cent of the reactor feed, again characterizing the process as one which achieves a significant amount of upgrading while maintaining high liquid yields.

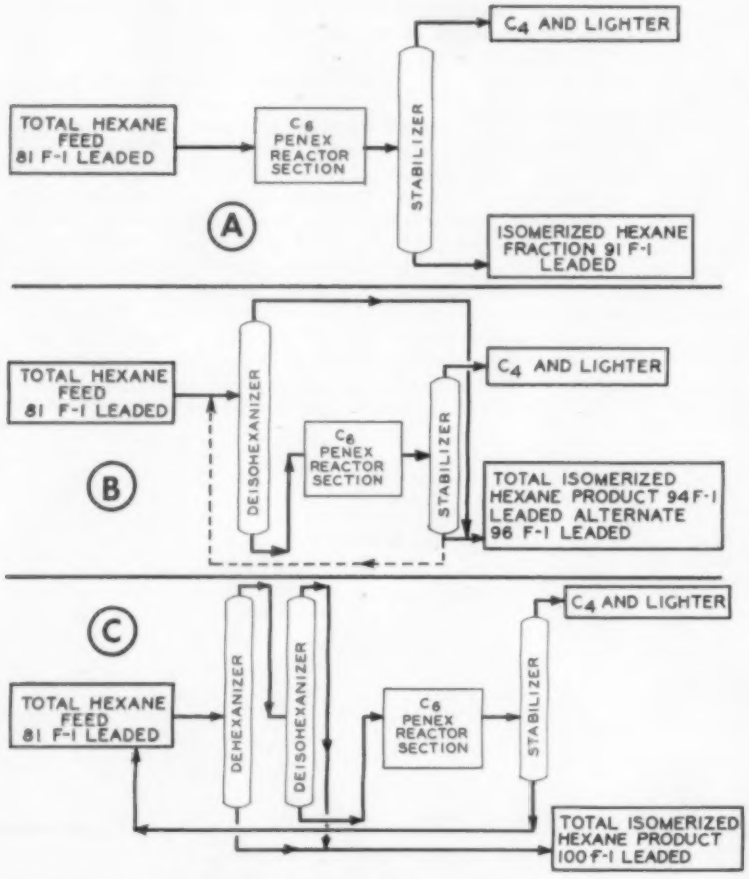
It is apparent, from the wide selection of flow schemes which can be adapted to any particular situation, that the plant and operating costs vary widely, depending largely upon the extent of upgrading accomplished. The cost involved in the processing shown in Fig. 5b is quite similar to that developed for the recycle C_5 Penex process previously discussed.

Simultaneous Processing

Where the streams to be processed are small in volume, and particularly where most of the upgrading is to be accomplished by the recycling of n-pentane to extinction, some economies in plant cost can be effected by charging the n-pentane and total hexane fractions simultaneously to the same reaction system.

In this case the total C_5 appearing in the reactor effluent is taken overhead in a depentanizer, and the n-pentane is recycled to the reactor following deisopentanization. The total product thus consists of isopentane plus the once-through isomerized hexanes.

Results of laboratory and pilot-plant work indicate that the C_5 and C_6 fractions are reacted to the same extent that they would be if processed separately. Liquid yields are somewhat lower because the operating conditions cannot be maintained at optimum values for each component, as can be done in separate processing schemes. **End.**



THREE TYPES OF FLOWS which may be used in processing hexanes. Fig. 5.

What a USER thinks of

AUTOMATIC DATA LOGGING

by E. C. MacMullan

THE Bayway refinery of Esso Standard Oil Co. has had an automatic data logger in service successfully on a process unit for 2 years. The installation, which is experimental, has been a testing ground for evaluating service factor, accuracy, and economic justification.

This work has shown that it is possible to install equipment of this type in a refinery control room. The logger can be satisfactorily maintained by a refinery instrument mechanic with periodic help from the manufacturer's serviceman. The accuracy of the data produced is high enough to permit its use for process accounting.

Justification of logging equipment remains a problem, however. It does not appear probable that the operating manpower on most refinery process units can be reduced by installation of a data logger. Accounting savings can be realized by the use of automatically logged data but the saving is too small to justify the entire logger.

Some reductions in control-room instrumentation can be made if the logger has provisions for single-point printout. However, this saving is also too small to justify the entire logger.

There are places in a refinery where a data logger could be justified by a combination of these advantages but they are few. The addition of control functions to a logger which could improve operation of the unit would expand the number of possible installations.

Author is with Esso Standard Oil Co., Linden, N. J. Paper presented at midyear meeting of the American Petroleum Institute's Division of Refining, Philadelphia, May 15, under the original title, "A User's Appraisal of Automatic Data Logging."

Equipment operation . . . The logging equipment is located in the control room of one of our polymerization units where it records 88 process variables. These are temperatures, pressures, and flow rates. Instantaneous values of temperature and pressure and integrated flow rates are printed out on an hourly cycle.

This cycle, however, can be adjusted to anywhere from once an hour to once every 5 minutes. A demand readout can be taken between scheduled readouts by simply pressing a button. It takes about 3.5 minutes to print out the 88 points.

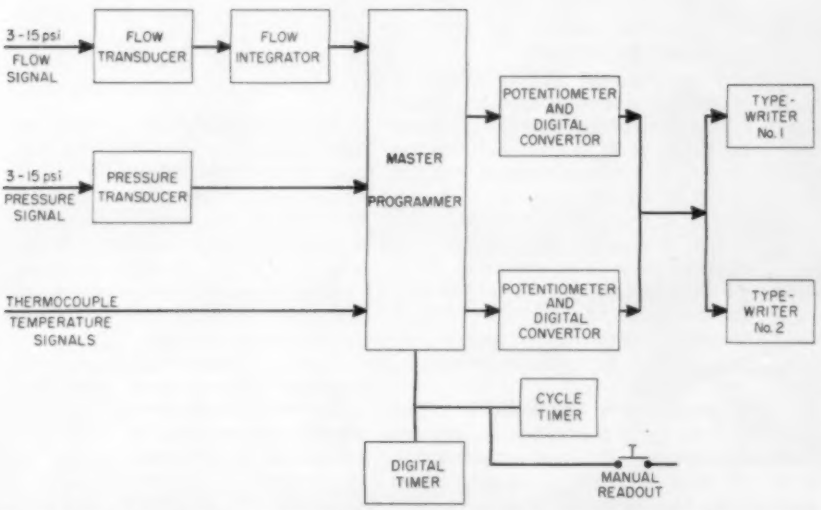
The operation of the equipment is best explained by reference to the block diagram shown in Fig. 1. There are three different input signals to this logger. They are:

1. 3 to 15-psi. flow signal.
2. 3 to 15-psi. pressure signal.
3. Thermocouple temperature signals.

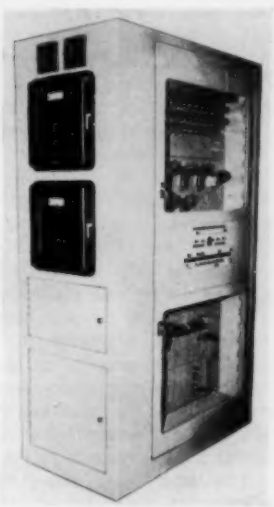
The air signals go first to an air-to-electromotive-force transducer. There are 38 of these air signals, each with a separate transducer. The flow signals then are integrated while the pressure signals go directly to the master programer. Thermocouple inputs come directly from the field to the programer. The programing is done by a series of telephone-type stepping switches which select one point at a time for processing and printing.

The signal to start a readout is sent from either the digital clock or the manual readout switch. Once such a signal is sent, the programer feeds one point at a time to a slide-wire potentiometer. After balancing, the shaft position of the potentiometer is converted into a digital signal which is transmitted to the typewriter. This process takes approximately 2 seconds.

Although Fig. 1 is a simplified block diagram, it does show all the essential functions of the logger. It can be seen, therefore, that this logger is a relatively simple one. It was kept this way because it was the first logger



THIS BLOCK DIAGRAM of automatic data logger shows all essential functions of logger. Fig. 1.



F. & P. automatic logger cabinet.

designed for continuous operation in a process plant. At the time it was designed, the practicability of some of the more complex logging functions was held in some doubt.

Operational Experience

One of the main reasons for the installation of this logger was to test its reliability in a continuous process unit. Therefore, the service factor and the type and amount of maintenance required were checked closely, particularly during the first 6 months of operation.

The first half of this period was devoted to "debugging" the equipment. For a period of 3 months following this, a close check of service factor showed an average of only 8 hours' down time a month. This is almost 99 per cent service factor. Routine maintenance was provided by one of our regular instrument mechanics; however, the manufacturer had a man available on a few hours' notice for any troubles which our man was not equipped to handle.

During this period maintenance time was estimated to be one-half a man-day per week. This included some preventive maintenance, notably the cleaning of relay contacts. This represents optimum conditions. The service factor has not always been at this high level for the past year. Extended continuous service has brought to light weaknesses in some of the components. Inasmuch as there was no previous experience available, some materials were specified which were not suitable for this service.

These components have been or are in the process of being replaced with better ones. It is felt that this high service factor can be reached again and maintained after these revisions are completed.

Another important question which had to be answered by this logger was that of accuracy. The accuracy requirements were kept high, with the intention of eventually using the data for accounting purposes. It was found that temperature readouts agreed with the master temperature indicator within 2° F. over 98 per cent of the time.

Integrated flow rates and pressure readings were checked and found to be accurate and reproducible within ±½ per cent. Occasionally a discrepancy would develop between the logger and a flow recorder. This was caused by the practice of compensating for drift in primary elements by zero adjusting the recorder. This problem is being solved by a redesigned pressure comparator.

This study has shown that it is practical to install equipment of such complexity in a continuous process unit. We believe that it can be maintained by our regular instruments mechanic with periodic help from the manufacturer's technicians. Furthermore, the equipment can meet the accuracy specifications necessary for this service.

Justification . . . This leads to the more fundamental question of justification. Granted that the equipment can do its job, is there any economic justification for installing it? Before attempting to answer this question, it should be mentioned again that this particular logger was the first to be installed on a process unit and it does not have some of the refinements found on subsequently installed equipment. These include scanning, monitoring, offnormal printout, and other control aids.

Therefore, this logger must be justified primarily on the basis of replacing a hand-written log sheet with a typed log sheet.

Loggers generally are expected to be justified by some or all of the following advantages:

1. Reduced operating manpower.
2. Reduced accounting work load.
3. Control-room investment credits.
4. More accurate data.

We have examined each of these potential advantages and tried to evaluate them in light of our experience.

1. Reduction in manpower . . . There is no doubt that a data logger reduces the work load on operating personnel. It is estimated that it would take half an hour to manually log the data now taken automatically. Without a logger this would be done only every 2 hours. This amounts to a saving of one-fourth of a shift man's time. It is very difficult to say whether or not the logger has reduced the manning of the unit on this basis.

In general, the limiting factor on manning is not work load but rather minimum safe manning during times of upset. It is conceivable that on some units the installation of a logger would be the deciding factor in permitting the reduction of manning by a full shift man. This would most likely occur on large units, with many points to be logged. To date, however, an automatic data logger is difficult to justify on process manpower savings alone in a petroleum refinery.

2. Reduction in accounting . . . This is a real but minor benefit, realized by replacing the hand planimetering of charts with integrated logger flow rates. The maximum saving for a single logger is one-fourth of an account's time. For this to be fully realized the logger should present flow rates integrated over a 24-hour period. This is not the case with the logger discussed here. It presents hourly integrated flow rates and the time to total these is not much less than the time required to planimeter and calculate them.

A further objection to use of this logger for accounting is the practice already mentioned, of compensating for drift in the primary element by zero adjusting the recorder. This causes a discrepancy to appear between the recorder and logger. Design changes are under way which will change the integration to a 24-hour period and which will permit zero adjustment of the logger to bring it into agreement with the recorder.

This will permit full utilization of the logger for accounting. In general, the accounting savings are sufficient to justifying the incremental cost of the integrators if the logger is justified in some other manner.

3. Control-room credits . . . A thorough check was made to see if the number of recording instruments on the control panel could have been reduced in view of the knowledge we now have of the reliability of the logger. It was found that 25 per cent of the logged points are remote controllers which cannot be replaced. Temperature points account for 55 per cent more and these are located in master indicators which occupy only 5 per cent of the panel area.

This leaves only a few instruments whose replacement can even be considered. Most of these were ruled out because a trend record was considered necessary at least part of the time, generally on startups. Two multipoint recorders could have been eliminated after certain slight modifications to the logger. This would have meant an investment credit of approximately $2,000.

4. More accurate data . . . This is the most difficult of all benefits to evaluate. Nevertheless, these are real advantages and their worth depends solely on the process in question. Under this heading comes the fact that a logger readout represents essentially simultaneous data. With a pencil log, the data represents a span of from 30 minutes to an hour.

Another consideration is that data is recorded during upsets when there is no chance to log data by hand. Still another factor is that the data is unbiased. These advantages in our logging system are appreciated, even if there is no way at this time of evaluating them economically. **End.**

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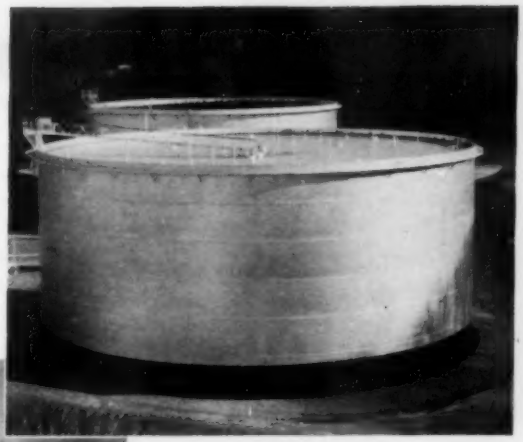

Above: Horton® Floating Roofs . . . ideal for storage of crude oil, gasoline and similar volatile liquids. They reduce evaporation loss, fire hazard and corrosion.

Left: Catalyst hoppers, reactor-regenerator and fractionating tower built by CB&I for a southern refinery.

Below: Hortonspheres® . . . best adapted to the storage of the more volatile liquids such as butane, butane-propane mixtures and volatile refinery stocks.

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Pentane Dehydrogenation

"... though yields are somewhat smaller, the process is more flexible, and gives higher octanes than isomerization ..."

by H. Shalit, F. W. Kirsch, W. S. Briggs, and J. B. Maerker

A PROCESS study of catalytic pentane dehydrogenation shows these results:

- Octane ratings of pentanes can be increased substantially, with excellent yields, by catalytic dehydrogenation over a Houdry chromia-alumina catalyst.
- Although excellent octane ratings can be obtained by thermal reforming of pentanes, yields are poor. Catalytic dehydrogenation provides octanes equivalent to those obtained from thermal reforming, at markedly higher yields.
- Pentane isomerization gives somewhat better yields than catalytic dehydrogenation, at equivalent octane ratings up to that of isopentane. However, dehydrogenation is more flexible in that it can utilize a wider range of feed compositions, including isopentane, and can produce higher octane ratings than those possible by isomerization.
- Attractive yield-octane relationships at very high octane ratings can be realized by combining pentane dehydrogenation and isomerization.

Scope of the study . . . This article presents the results of early studies of the application of the Houdry dehydrogenation process to pentane dehydrogenation for octane improvement. Data were obtained from dehydrogenation of n-pentane, isopentane, and mixtures of these compounds over a chromia-alumina catalyst. Thermal processing data also were obtained for comparison with the catalytic dehydrogenation results.

In addition, catalytic isomerization is discussed in order to compare dehydrogenation and isomerization as means of upgrading pentane fractions and to describe results obtained from combining these two processes.

The purpose of this study was to obtain process data for preliminary evaluation of catalytic dehydrogenation of pentane fractions for octane improvement. The results indicate that further work is justified in order to develop the process.

Authors are with Houdry Process Corp., Marcus Hook, Pa. Paper presented at A.P.I. Refining Division meeting, May 16, 1957, Philadelphia, under the original title, "High-Octane Blending Components From Pentanes."

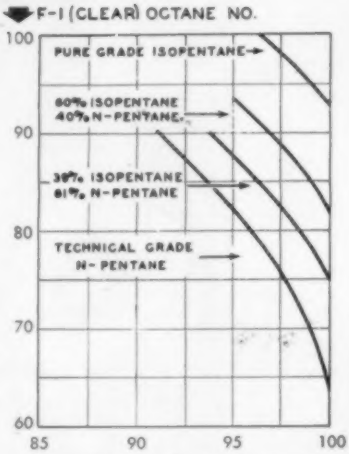

Fig. 1—Yield-octane curves for pentane dehydrogenation. NOTE: "F-1 (clear) Octane No." corresponds to A.S.T.M. octane number (D 908 research method) without TEL addition.

Pilot-plant work . . . The catalytic dehydrogenation data were obtained from a fixed-bed isothermal pilot unit. The catalyst used was a Houdry chromia-alumina dehydrogenation catalyst. Charge stocks used were technical-grade n-pentane, pure-grade isopentane, and mixtures of these compounds.

Hydrocarbon distribution in the product was obtained by a combination of distillation, vapor fractometry, and mass spectrometry. Octane ratings were determined on the C_4-free dehydrogenation product. Some octanes also were determined on a blend of 20 per cent by volume of product and 80 per cent by volume of a typical refinery gasoline pool.

The experimental dehydrogenation data were obtained from a series of atmospheric-pressure runs in which space rate, temperature, and on-stream time were varied over a relatively wide range. Feed-stock composition was varied, as follows:

	Per cent by weight			
n-Pentane	96	61	40	0
Isopentane	4	39	60	100

The charge stock containing 60 per cent of isopentane approximates the equilibrium isonormal composition at 800° to 900° F., and the charge with 39 per cent of isopentane represents a typical composition found in natural gasoline. Approximately half of the experiments were single-cycle runs. When larger amounts of product were required, cyclic operation was used. However, optimum cycle time and on-stream time were not determined.

Yields-octanes . . . Yield-octane-number relationships obtained for catalytic pentane dehydrogenation are presented in Fig. 1. These curves are drawn from experiments at all of the space rates and temperatures investigated. All the data show excellent yields at octane ratings substantially higher than the unprocessed charge.

By dehydrogenation, n-pentane with a 63.5 research octane number, clear, is upgraded to an 85 octane rating, at a 94 per cent yield. Isopentane is upgraded from 92.3 to 99 research octane number, clear, with a 97 per cent yield. The octane attainable at any yield increases as the isopentane content of the charge increases.

Yield-blending-octane-number relationships for the two mixed pentane charge stocks are presented in Fig. 2. The blending octane numbers are lower than the actual octane numbers. However, this difference is no greater, and is perhaps less, for the dehydrogenated products than for a paraffin mixture.

For example, a mixture of 60 per cent of isopentane and 40 per cent of n-pentane, with an 82 research octane number, clear, has a blending octane

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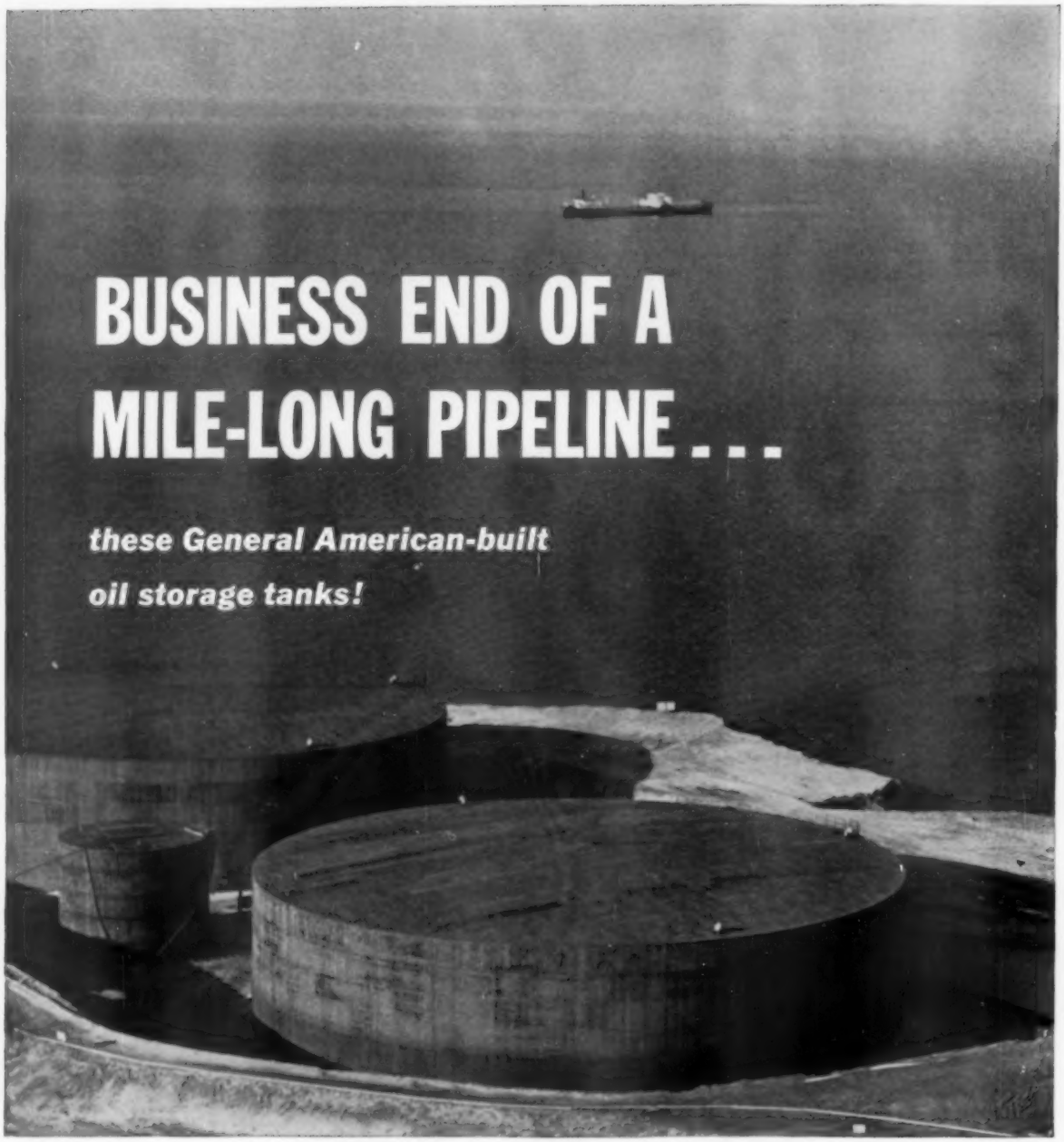

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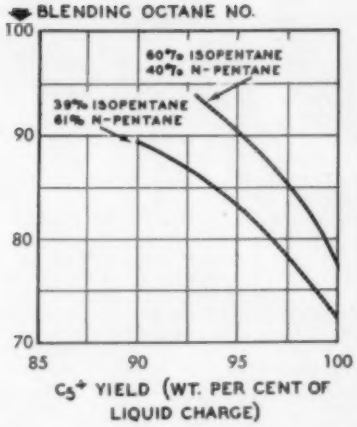

Fig. 2—Yield-blending curves for dehydrogenation of pentane mixtures (with blends of 20 per cent by volume in a typical refinery gasoline pool).

number of 77. A dehydrogenated product from this mixture has 93.5 research octane number, clear, and a blending number of 90.5.

Fig. 3 presents product distribution and C_5 unsaturate yields as a function of the C_5 yield for both n-pentane and isopentane dehydrogenation. The yields for mixed pentane feeds lie between the curves for n-pentane and isopentane. The yield of unsaturated C_5 compounds demonstrates the reason for the octane improvement by dehydrogenation.

It is known that olefins, in general, are of higher octane number than the corresponding paraffins; thus 2-methyl, butene-2 — with the same carbon skeleton as isopentane—has a 99.1 research octane rating, clear, compared to 92.3 for the isoparaffin.

Although coke yield from n-pentane is higher than that from isopentane, the coke yields obtained are within the operable range for commercial adiabatic operation. Slightly higher gas yields are obtained from isopentane dehydrogenation than from n-pentane dehydrogenation.

A limited number of thermal reforming runs were made in the same equipment used for the catalytic studies. In these instances the reactor was packed with quartz instead of catalyst. The charge used was 37 per cent of n-pentane and 63 per cent of isopentane. Results are presented in Table 1.

Total pressure was 800 psig., and oil partial pressure and contact time were varied by charging nitrogen with pentanes. It is apparent that high octane ratings can be obtained, but C_5+ yields are low. For example, at 1,050° F. a 96.9 research octane number, clear, was obtained, but the C_5+ yield was only 55.9 per cent by weight.

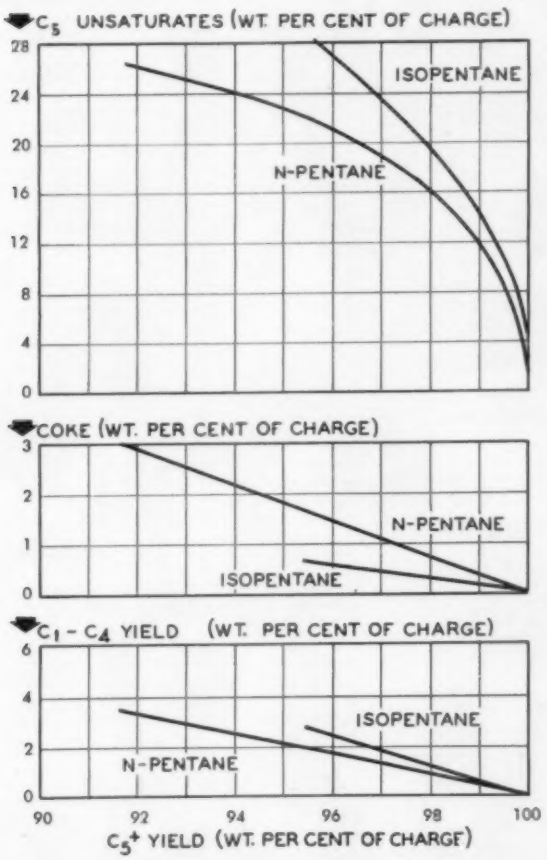

Fig. 3—Product distribution for pentane dehydrogenation.

Results

The results presented in the foregoing demonstrate that catalytic dehydrogenation is a potential process to improve the octane rating of pentanes for use in motor gasoline. Inasmuch as the octane obtainable is higher than that by methods currently being considered, and yields are excellent, the process will become even more important as octane requirements increase.

The typical refinery will have available a mixture of pentane isomers. Consequently, the catalytic dehydrogenation data have been crossplotted to show yields and octane ratings as a function of feed-stock composition. This correlation is presented in Fig. 4. It is clear that as the isopentane content of the charge is increased, higher octane levels can be reached, or higher yields can be reached at a constant octane rating.

During the catalytic dehydrogenation studies, it was found that small amounts of C_5 diolefins were produced. Because the yields of diolefins was low—1 to 5 per cent of the dehydrogenation charge — the diolefins are not expected to affect the gum-forming tendencies of the final gasoline pool in a detrimental fashion.

The octane ceilings which can be obtained by thermal reforming and catalytic dehydrogenation of C_5 fractions are similar. However, catalytic dehydrogenation provides substantial yield advantages over thermal reforming, as shown in Table 2. At essentially the same octane rating, the yield from catalytic dehydrogenation is almost 30 per cent by weight of charge greater than that from thermal reforming.

Catalytic isomerization of C_5's is limited to a research octane rating, clear, of approximately 84 for the equilibrium product if no pentane-isomer distillation facilities are used. With precise fractionation, isopentane can be separated from the product and n-pentane recycled, to provide isopentane product with a 92.3 research octane rating, clear, at a reported yield of approximately 98 per

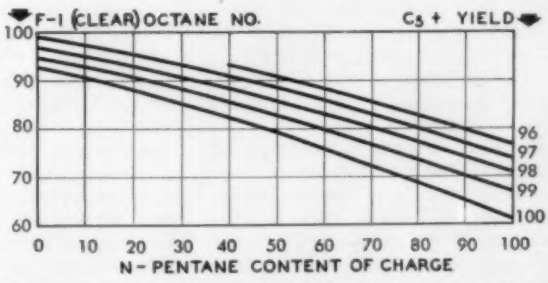

Fig. 4—Composition-octane-yield correlation for pentane dehydrogenation.

TABLE 1—THERMAL REFORMING OF PENTANES

Total pressure: 800 psig.
Charge stock: 37 per cent of n-pentane, 63 per cent of isopentane.

	Run No. 1	Run No. 2	Run No. 3
Temperature, °F.	1,000	1,000	1,050
Contact time, minutes	6.3	8.5	8.2
Oil partial pressure, psi.	369	497	493
A.S.T.M. octane number (D 908, research method), without TEL addition	94.2	95.1	96.9
Yield, per cent by weight of oil charge:			
C_5	67.7	62.6	55.9
C_4	13.0	16.4	17.1
C_3	7.3	12.2	12.1
$C_1 + C_2$	11.5	8.5	14.6
H_2	0.2	0.0	0.0
Carbon	0.3	0.3	0.3

TABLE 2—COMPARISON OF CATALYTIC DEHYDROGENATION AND THERMAL REFORMING

	Catalytic dehydrogenation	Thermal reforming
Charage, per cent by weight:		
n-Pentane	40	37
Isopentane	60	63
A.S.T.M. octane number (D 908, research method), without TEL addition	93.5	94.2
C_5+ yield, per cent by weight	95.0	67.7

TABLE 3—COMPARISON OF n-PENTANE AND n-PENTANE-ISOPENTANE CHARGES IN THREE PROCESSES

	n-Pentane (63.5)			61 per cent of n-pentane, 39 per cent of isopentane (75)		
Charge (research Oct. No., clear)—	Catalytic dehydrogenation	Isomerization without distillation	Isomerization with distillation	Catalytic dehydrogenation	Isomerization without distillation	Isomerization with distillation
Product, A.S.T.M. octane number (D 908, research method), without TEL addition	94	84.5	†92.3	94	84.5	†92.3
C_5+ yield, per cent by weight	89	*98	*98	91	*98	*98

*Assumed value. †Pure isopentane.

TABLE 4—TYPICAL RESULTS FROM COMBINATION ISOMERIZATION-DEHYDROGENATION PROCESSING

Feed: 61 per cent of n-pentane, 39 per cent of isopentane, with a 75 research octane number, clear.

	Catalytic dehydrogenation	Isomerization without distillation	Isomerization with distillation	Isomerization without distillation + catalytic dehydrogenation	Isomerization +distillation + catalytic dehydrogenation
A.S.T.M. octane number (D 908 research method), without TEL addition	94	84.5	†92.3	93.5	99.0
C_5+ yield, per cent by weight	91	*98	*98	‡93	‡95

*Assumed value. †Pure isopentane. ‡Calculated, based on assumed isomerization yield and known yield from dehydrogenation yield-octane curves.

cent. As shown before, results of catalytic dehydrogenation depend on the charge composition, but, in general, higher octane numbers can be realized than with isomerization at only a moderate sacrifice in C_5+ yield. This comparison is shown in Table 3.

Various combinations of dehydrogenation, isomerization, and distillation can produce products with octane numbers higher than those tabulated in Table 3. Results obtainable by several of these combinations are presented in Table 4. These data further show the advantages of dehydrogenating material with the highest possible isocontent. Octane ratings even higher than the 93.5 and 99.0 shown for the combination schemes can be obtained, with small additional yield sacrifices.

Obviously the refiner's choice of processing schemes will depend on a number of factors. These include the pool octane-rating contribution required by the C_5 fraction, as well as the cost and economics of catalytic dehydrogenation, isomerization, fractionation, and combinations of these processing steps. Work is currently in progress to simplify the dehydrogenation process and to extend the early data reported herein. The additional data will provide bases for economic evaluations of the different combinations.

BOOKS

SCENIC TRIPS TO THE GEOLOGIC PAST, CIRCLE DRIVE, TAOS-RED RIVER-EAGLE NEST, NEW MEXICO, by John H. Schilling. Published by State Bureau of Mines and Mineral Resources, New Mexico Institute of Mining and Technology, Socorro, N. M. 28 pp., available free of charge upon request.

This is the second in a series of informative guide books published by the State Bureau of Mines and Mineral Resources, a division of the New Mexico Institute of Mining and Technology. It is designed to acquaint both the geologist and the layman with the local and interesting geology of the State of New Mexico.

A complete road log is given for the Circle Drive starting at Taos and covering the Red River-Eagle Nest area.

GEOLOGIC ATLAS OF UTAH, EMERY COUNTY, by William Lee Stokes and Robert E. Cohenour. Published by Utah Geological and Mineralogical Survey, College of Mines and Mineral Industries, University of Utah, Salt Lake City. 96 pp. $5.

This new geologic atlas covering Emery County, Utah, is a big step forward in presenting the geologist with a useful pocket-sized coverage of an area. The Utah Geological and Mineralogical Society has provided a very convenient geologic atlas. It is simply designed, scientifically accurate, and convenient to use.

It has been carefully streamlined to fit the needs of oil geologists, uranium prospectors, and other people interested in the geology of the county. Although the scale is large—½ in. to the mile—the atlas is unique because it has no loose maps, nor pouches in the back.

In the past, geologic map makers have faced a dilemma—either the scale is too large, or the map is too small. The result is often a huge affair which must be either folded or rolled. This new presentation eliminates that by dividing the county up into segments roughly 12 miles long by 9 miles wide. These segments are presented in color on separate pages of the book, making them very handy for the field geologist.

STUDY OF ATMOSPHERIC EMISSIONS FROM OIL REFINERIES published by the Los Angeles County Air Pollution Control District. A limited number of these reports are available and may be obtained by writing to Carl V. Kanter, 434 South San Pedro Street, Los Angeles 13.

This progress report details the purpose, scope, and initial findings of the study and outlines the procedures for future source investigations. Included are discussions of plumes, cooling towers, air blowing, valves, flanges, storage tanks, pumps, and catalytic cracking units.

LIST OF PUBLICATIONS from American Society for Testing Materials, 1916 Race Street, Philadelphia 3.

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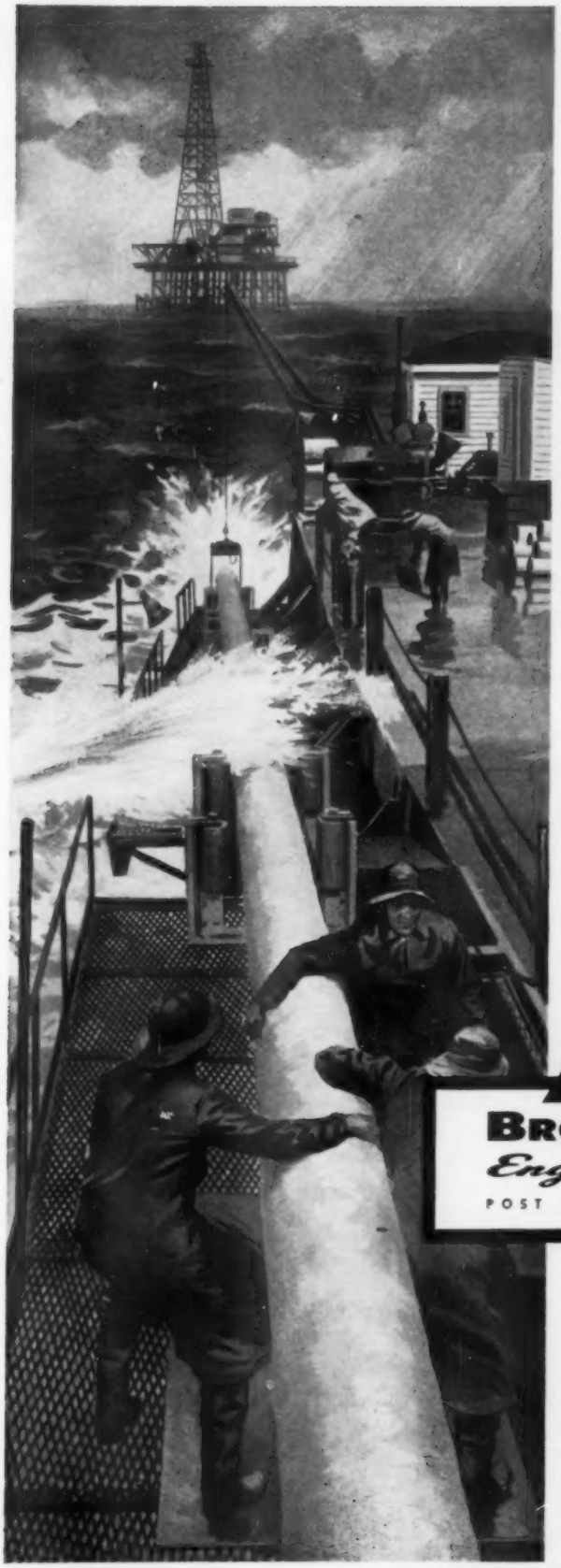
Note: The Oil and Gas Journal maintains a book department. Write to the READER SERVICE DEPARTMENT, P. O. Box 1260, Tulsa 1, for copies of the book list. Often books reviewed here may be purchased from this source.



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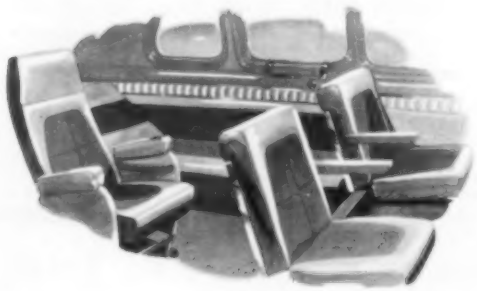

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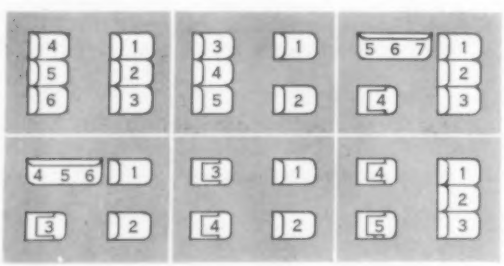

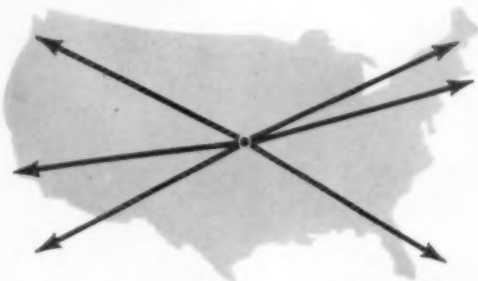

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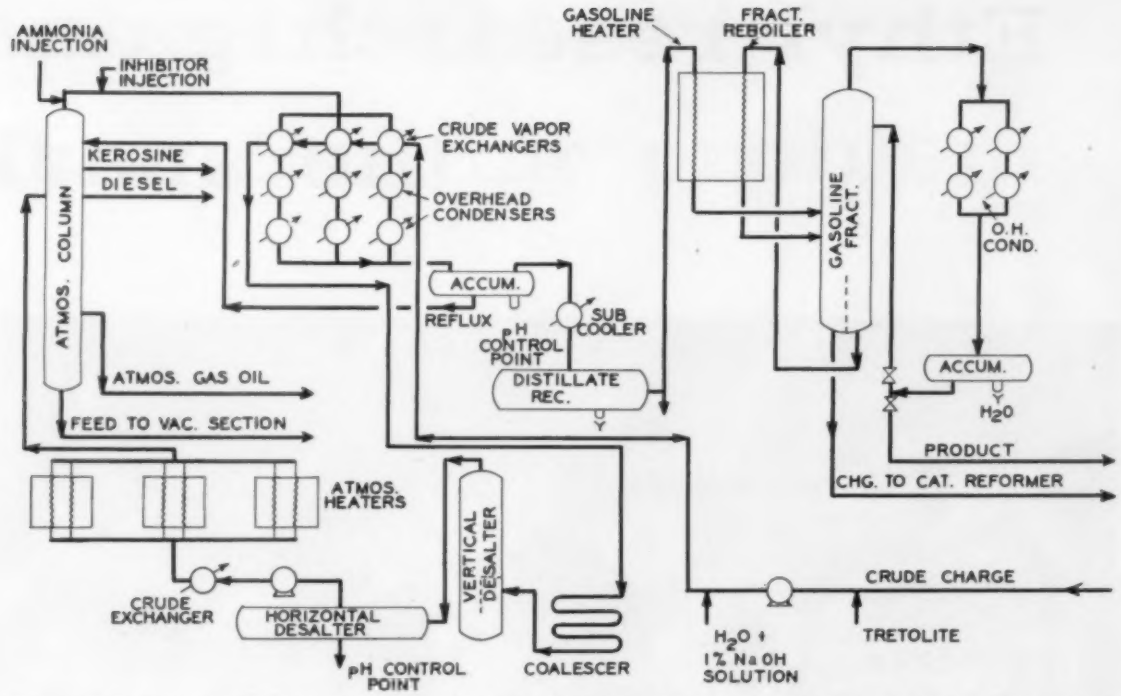

SIMPLIFIED FLOW DIAGRAM of crude-oil unit showing desalting, atmospheric, and gasoline fractionation sections. Fig. 1.

A 27-month period of testing demonstrates to Ohio Oil that . . .

Low-pH Receiver Waters Cut Corrosion

. . . in a crude-oil unit. And aftereffects have been eliminated

by J. A. Biehl and E. A. Schnake

OPERATION and corrosion studies of a crude-oil unit at high and low pH of overhead waters showed that the pH of the receiver waters should be reduced to about 4.3, with inhibitor injections varying from 10 to 15 p.p.m.

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Unit flow . . . Ohio Oil Co.'s Robinson, Ill., refinery processes Illinois basin crude oil which has an average Baumé gravity of 36.0° and a sulfur content of 0.23 per cent (high, 0.36 per cent). The salt content, expressed as sodium chloride, averages approximately 30 lb. per 1,000 bbl. of crude oil.

The maximum salt content for the past year was 259 lb. per 1,000 bbl., and the minimum 14 lb. per 1,000 bbl. The general arrangement of the desalting, atmospheric, and gasoline fractionating sections is shown in Fig. 1.

The crude oil is desalted before processing in a chemical desalting unit. A demulsifying agent is injected into the raw-crude stream directly ahead of the crude-oil unit pump suction in order to obtain maximum mixing. Five per cent by volume of water and a 1 per cent solution of sodium hydroxide are injected into the crude oil after the pump suction and the orifice flange in order to prevent plugging of the orifice.

The caustic injection is regulated in order to maintain a pH of 8.0 on the water draw from the horizontal desalter vessel. The raw-crude mixture is then passed through the conventional exchangers where it is preheated to a temperature of 260° F. before entering a vertical desalter and passing into a horizontal desalter where a pressure of 160 psi. is maintained.

From these vessels the water separated is withdrawn to the sewer system. The desalted crude oil averages approximately 1.23 lb. of salt per 1,000 bbl. Control for this average is possible by varying the quantities of water and by addition of the demulsifying agent. The efficiency of the desalting process averages 95 per cent.

Desalted crude . . . The desalted crude oil flows through additional heat exchangers and parallel heater

Authors are with Ohio Oil Co., Robinson, Ill. Paper presented at midyear meeting of the American Petroleum Institute's Division of Refining, Philadelphia, May 13, under the original title, "Corrosion in Crude-Oil Processing."

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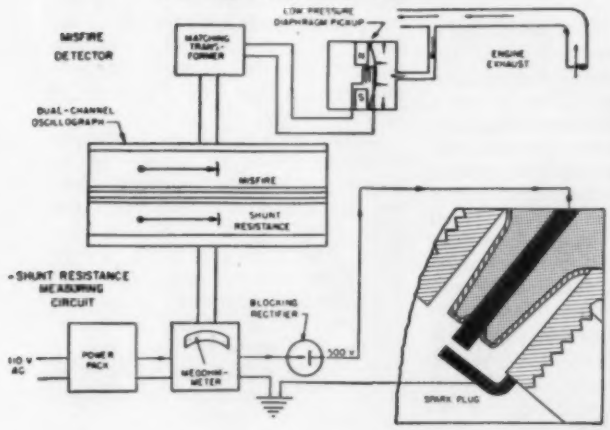
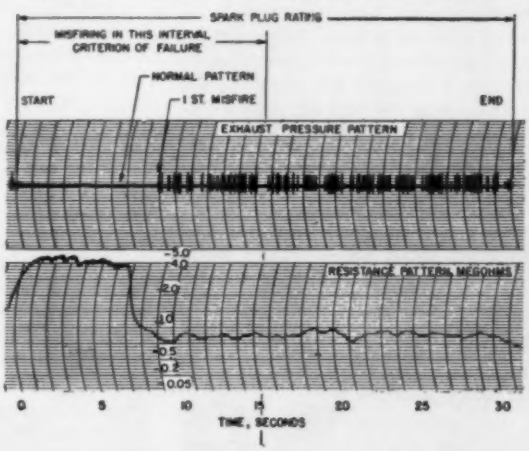
Block Diagram of Spark-Plug Instrumentation



Actual Misfire and Shunt Resistance Patterns of a Fouled Spark Plug



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banks into the flash zone of an atmospheric column (23 trays) at a temperature of 610° F. The tower is operated at a pressure of 10 psi., with the overhead temperature controlled at 310° F. Three side streams of kerosine, diesel, and atmospheric gas oil are removed from the tower, and the column bottoms are charged to the vacuum unit.

The atmospheric column overhead, comprising approximately 30.83 per cent of the crude-oil charge as gasoline plus process steam, passes through the shell side of three parallel crude-vapor exchangers. The overhead next passes through three parallel banks of condensers, with two condensers in series in each bank.

The material then enters the reflux accumulator drum at a temperature of approximately 130° F. The major portion of the water, approximately 650 bbl. per day, is withdrawn at this point. A major portion of the hydrocarbon phase is returned as reflux to the top tray of the atmospheric tower. The remaining gasoline distillate is further cooled through additional subcoolers and flows to the distillate receiver.

The distillate is then charged to the gasoline fractionator, where the heavy naphtha is separated for charge to the catalytic reformer and the light naphtha sent to the continuous treaters.

Construction Material

All transfer lines, furnace tubes, furnace headers, heat-exchanger and condenser shells, heat-exchanger tubes, vessels, and accumulators in the unit (except the lining of atmospheric and gasoline fractionating towers) were constructed of carbon steel. All condenser tube bundles were of inhibited admiralty material.

The atmospheric tower was lined with Type 410 (11 to 13 per cent of chromium) alloy in the hot section and with monel alloy in the upper, cooler section. The gasoline fractionator was lined throughout with Type 410 alloy.

Experiences at High pH

The crude-oil unit was originally placed on stream during the summer of 1949, at a charge rate of 25,000 bbl. per day. At this time, and during all of the initial runs, the pH of the desalter effluent was maintained at 8.6 and the pH of the reflux accumulator water controlled between 6.8 and 7.5. With this charge rate, the corrosion was rather mild. The unit was completely inspected annually for 2 years, after which several atmospheric heater outlet tubes were replaced, as a result of corrosion, with 2½ per cent chromium-½ per cent molybdenum alloy.

At the same time the carbon-steel transfer line from the atmospheric furnace to the column required replacement, and a 4 to 6 per cent chromium-½ per cent molybdenum alloy was substituted. Replacement of these carbon-steel tubes and lines with alloy has satisfactorily controlled this corrosion. During this operational period the corrosion of overhead equipment was rather mild, and no material replacement was required. Moderate pitting was observed near the outlet of overhead crude-vapor heat-exchanger shells and on the bottom of the upper bank of atmospheric overhead condenser shells.

Moderate concentrated pitting was also observed on the top admiralty bundles at overhead condenser inlets. The reflux accumulator and distillate receiver indicated mild attack, except for the bottom quarter of the vessels, which showed an over-all corrosion of 0.01 in. per year. Several small hydrogen blisters were noted in the distillate receiver immediately above the water interface layer.

Severe corrosion . . . After the 1951 turnaround inspection the crude-oil charge rate was slowly increased to 36,000 bbl. per day. After a year's operation the unit was again inspected and, at this time, corrosion and fouling were rather severe. The carbon-steel tubes of the overhead crude-vapor heat exchangers were generally pitted at a rate of 0.015 in. per year. The depth of pitting of the exchanger shells also showed considerable increase.

The three top inhibited-admiralty overhead condenser bundles in the atmospheric section were completely retubed because of severe localized pitting at the inlet, and there was also severe corrosion under the accumulated sludge in the bottom section of the bundles and ahead of the baffles.

The three bottom overhead condenser bundles, which had shown no corrosion previously, were generally attacked under a sludge layer.

The reflux accumulator and distillate receiver showed some hydrogen blistering. At the turnaround, hydrogen probes were installed in the reflux accumulator and distillate receiver. Connections were installed on the lines between crude-vapor exchangers and receivers for the purpose of evaluating corrosion inhibitors. Several admiralty tubes of the overhead condensers of the gasoline fractionator were found to be cracked as a result of ammonia attack during hydrostatic testing.

Amine-type inhibitors . . . During the next run (1952 to 1953) amine-type corrosion inhibitors were evaluated. The comparison was made by means of test coupons, water analysis, and hydrogen probe activity. Without inhibitor injection, hydrogen activity was high, with a pressure accumulation of 89 psi. in approximately 30 days. With inhibitor injection, hydrogen activity was practically nil. Although coupon studies and water analyses lack uniformity and dependability, the results obtained indicated increased protection from inhibitor injection.

As the result of the inhibitor evaluation program, it was decided that both ammonia and inhibitor injection should be employed for corrosion protection. Before the program could be initiated, the unit was brought down as a result of corrosion failure of the three carbon-steel crude-vapor exchanger bundles which required replacement. It was also again necessary to replace the top three inhibited-admiralty overhead condenser tube bundles in the atmospheric section. Blistering of the reflux accumulator and distillate receiver was severe enough to require replacement of the receiver. The bottom half of the new receiver and the accumulator were lined at this time with a mixture of lumnite cement and sand.

During the following year's run (1953 to 1954), an amine-type inhibitor was injected continuously into the atmospheric overhead vapor line at a rate of 6 p.p.m. of the total overhead. The hydrogen probe activity during this run was rather light, with a maximum accumulated probe pressure of 7 psi. in 10 days. Several attempts were made to reduce this activity by increasing the inhibitor injection; however, water-oil emulsion and carryover resulted.

Although there was a considerable improvement in fouling, corrosion, and scaling of the equipment, it was still necessary to replace the top section of tubes in each of the three upper atmospheric overhead condenser bundles at the next turnaround inspection. The unit was brought back on stream with an inhibitor injection rate of 6 p.p.m. The pH of the overhead receiver water was now controlled at 7.0 by ammonia injection.

Ammonia troubles . . . With the start of ammonia injection, difficulties were experienced at other process units. Ammonia and its compounds were found in all overhead and side streams of the atmospheric fractionating operation at the crude-oil unit. The light gasoline naphtha carried the ammonium constituents through the

caustic washes and into the Linde copper-sweetening unit. The ammonia caused high consumption of treating chemicals, high copper content in treated gasoline, and severe corrosion of lines carrying the treated stocks.

The heavy naphtha carried the ammonium constituents into the reactor sections of the reformer, which disturbed catalyst activity by stripping the chloride ions from the catalyst. Fouling of the preheater section of the reformer was also attributed partly to ammonium salts as well as to oxidizable sulfur and dissolved oxygen. The effect on kerosine was the same as on the light gasoline naphtha because this stream was also copper-sweetened.

The effect on the diesel stream was in its quality, inasmuch as the ammonium constituents caused deterioration of copper materials normally used in motor injector systems and fuel lines. The settled moisture in rundown and storage tanks resulted in some corrosion of tank bottoms. The corrosion was very likely the result of dissociation of the ammonium components into acid and ammonium ions. The ammonia migrated into the hydrocarbon layer, which resulted in a decreased pH of the water layer.

No specific effect was observed on the gas-oil streams, even though it is a proven fact that nitrogen affects the activity of fluid cracking catalysts.

Transition

The adverse effect of high-pH operation of crude-oil overhead receiver waters on other processes and the continued corrosion problems indicated that studies should be initiated regarding the chemistry of this operation. The chemistry of corrosion at this high-pH operation was found to be very complex, and the studies which were conducted indicated that physical properties of compounds played a major role.

Even with the use of an inhibitor, corrosion was experienced; and it resulted particularly in the loss of admiralty tubes and in the accumulation of iron sulfide deposits, especially in areas of low flow rate. Corrosion rates, as previously mentioned, could not be estimated by analysis of iron and copper in the water phase because the pH was such that iron and copper sulfides would precipitate and be deposited or carried by the hydrocarbon phase.

Dissociation . . . The corrosion at the high pH was attributed to the dissociation characteristics of the ammonium compounds. The first dissociation reaction studied was that of ammonium chloride. The reaction is written as follows:

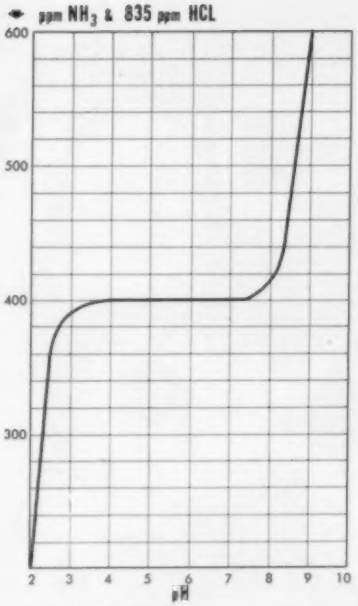
$$H(NH_3)Cl = HCl + NH_3$$

It was felt that this reaction should not be considered as hydrolysis in solution, but rather as a natural splitting off of ammonia.[1] The stability of ammonium chloride depends upon the hydrogen-ion concentration. The greater the hydrogen-ion concentration, the more the equilibrium is shifted to the left; therefore, low pH would favor the formation and stability of ammonium salts. The greater the pH, the more dissociation into hydrogen chloride and ammonia.

Ammonium sulfide stability depends considerably upon pressure and temperature. This is reflected by the following dissociation pressure table[2]:

Degrees Fahrenheit	Millimeters of mercury
39.4	132
71.6	410
90.0	772
111.4	1,560

Because it was known that the operational temperatures were considerably higher and the pressures lower than the values shown in this table, it was realized that the dissociation of ammonium sulfide would be almost complete. Without knowledge of the dissociation characteristics of ammonium chloride and sulfide, we attributed our corrosion problem to the reactivity of the dissociated components, which would be (1) ammonia, (2) hydrogen chloride, and (3) hydrogen sulfide.



ELECTROMETRIC titration curve of ammonia-hydrogen chloride neutralization. Fig. 2.

The activity of these components made the formation of sulfide film and inhibitor films very complex and not always effective. The types of corrosion which result from these constituents have been explained in detail by other authors.[3,4,5,6]

On the basis of these dissociation characteristics, a study was made to determine how the operation could be altered in some manner in order to give adequate corrosion protection of the overhead equipment and still prevent ammonia contamination of hydrocarbon streams. The simplest method of eliminating such contamination would be to eliminate ammonia injection. This would then present a problem of corrosion protection unless some means were devised to provide a protective film on the equipment.

This method which appeared to be the most logical was to use an amine-type inhibitor at increased dosages. Because it was realized that this type of inhibitor was not too effective against hydrogen chloride attack, electrometric titration curves were established for hydrogen chloride and ammonia neutralization. It was found that the neutralization occurred at a pH of 3.2 to 3.5 (Fig. 2). It was believed that, by neutralizing the hydrogen chloride with ammonia to a pH of 3.5 to 4.5, the inhibitor would provide the necessary protection against hydrogen sulfide attack.

Lower pH . . . After the foregoing evaluation of the problem had been made, it was decided to reduce ammonia injection and operate at a pH of 3.5 to 4.5 on the overhead receiver waters; however, the inhibitor injection was increased to 12 p.p.m. During this transition, high total iron contents of receiver waters were anticipated for a period of time as a result of the cleansing action expected from the increased inhibitor addition and the lower pH.

This was found to be true, but after approximately 4 months of operation the total iron decreased to an average level of 2 p.p.m. and the copper to an average level of 0.6 p.p.m. Unlike those following the high pH operation, the iron and copper analyses were now dependable.

Experiences at Low pH

The low pH operation was started September 1, 1954, and at this time the pH of reflux accumulator water was maintained at an average level of between 3.5 and 4.5, with an inhibitor injection rate of 12 p.p.m. of total overhead. After approximately 4

months of operation, the average pH level was raised to between 4.3 and 5.4, with an inhibitor injection rate of 9 p.p.m. The reason for going to slightly higher pH levels was the possible prevention of corrosion by acidic compounds in the gasoline fractionator overhead.

At this time, no additional inhibitor was injected into the fractionator overhead because of possible adverse effects of inhibitor breakdown in other process units. No connections were available for insertion of corrosion test coupons or hydrogen probes as a corrosion guide in the gasoline fractionator section. This pH level of 4.3 to 5.4 of reflux accumulator water was maintained until an inhibitor was added to the gasoline fractionator overhead approximately 9 months later. At that time, the pH level was again reduced to the range of 4.0 to 4.5, with an average inhibitor injection rate of 12 p.p.m.

At the start of low pH operation of the overhead equipment, the total crude-oil charge to the unit was 36,000 bbl. per day. In order more effectively to protect against corrosion under these conditions, the injection rate of the organic amine inhibitor was increased, as just mentioned. As a check on corrosion rates, test coupons, hydrogen probes, and analyses of overhead waters for iron and copper contents were utilized.

Coupons . . . Removable corrosion test coupons of steel and inhibited admiralty were inserted at various locations in the lines between the exchangers and the reflux accumulator of the atmospheric tower overhead. These coupons were removed for inspection after approximately 1 month of operation, and all coupons indicated a general attack. Two coupons, one each of steel and admiralty, were removed for further checks and replaced with new coupons.

The remaining test strips were replaced after visual inspection only and without cleaning or removal of any film. After the second month of operation, inspection revealed that the two clean coupons again indicated a rather general attack, and that the remaining coupons which had not been cleaned showed no further corrosion activity as far as could be determined by visual inspection. The coupons were then all replaced without cleaning and when next inspected, after approximately 6 months of operation, very little, if any, increase in corrosion attack was found.

The corrosion test coupons indicated a rather high initial corrosion attack of clean surfaces and also that once a protective film was established, equipment should be cleaned only to correct fouling conditions. The initial rate of attack, as determined from the first samples removed, was approximately 0.04 in. per year for carbon steel and 0.018 in. per year for admiralty. The rate of attack after 6 months, however, was well below acceptable levels.

Hydrogen probes, which had been installed at the time blistering damage occurred in the atmospheric column reflux accumulator and distillate receiver, were now checked daily at low pH operations for any indications of hydrogen activity. Except for an occasional small pressure buildup, the probes remained at zero. These pressure gains were usually noted immediately after operation at a rather low pH (3.7 to 4.1). Although confirming data are lacking, it is also suspected that arsine is a contributor to hydrogen activity.

Other checks . . . The water from the atmospheric column reflux accumulator and from the overhead accumulator (receiver) of the gasoline fractionator was checked twice weekly, for iron and copper analyses, as a third means of checking corrosion. Laboratory results of these analyses for the first 6 months are compared with later results in Table 1.

The results were more or less as expected; however, it took considerably longer for the iron and copper contents to decrease than originally was anticipated. The iron in the water increased immediately, but the copper content did not increase appreciably until after approximately 3 months' operation, with both reaching a peak after approximately 4 months and then decreasing rapidly to low levels.

The unit was inspected at the regularly scheduled turnaround inspection in May 1955, following 9 months of operation at low pH levels of overhead receiver waters. The condition of equipment, from both a corrosion and cleanliness standpoint, was good—actually better than had been antici-

TABLE 1—LABORATORY ANALYSES OF OVERHEAD RECEIVER WATERS

First 6 Months of Operation at Low pH

	Reflux accumulator			Gasoline fractionator receiver		
Date—	pH	Fe (p.p.m.)	Cu (p.p.m.)	pH	Fe (p.p.m.)	Cu (p.p.m.)
September 14, 1954	3.5	4.4	0.4	4.8	280.0	0.2
September 16, 1954	4.2	5.1	0.4	4.8	193.0	0.3
September 20, 1954	3.9	5.9	0.2	4.8	220.0	0.1
October 8, 1954	4.2	4.0	0.3	5.0	138.0	0.3
November 5, 1954	4.5	4.2	0.7	5.0	15.8	0.7
November 26, 1954	4.5	14.0	5.7	4.8	24.0	1.5
December 16, 1954	4.5	12.0	4.8	5.0	16.0	3.6
February 4, 1955	4.6	2.0	3.0	5.5	8.0	2.3
February 18, 1955	4.7	1.0	0.8	5.3	2.0	1.5
Last 6 Months of Operation at Low pH						
May 24, 1956	4.3	2.0	0.8	4.7	2.0	1.3
June 15, 1956	4.1	2.0	0.5	4.4	2.0	1.0
June 29, 1956	4.2	2.0	0.6	4.9	3.0	0.3
July 13, 1956	3.2	1.6	0.5	3.4	1.6	1.0
July 20, 1956	4.3	0.0	0.3	4.8	2.0	0.2
August 23, 1956	4.4	0.0	0.3	5.0	2.0	1.0

TABLE 2—CORROSION RATES AT CRUDE-OIL UNIT ATMOSPHERIC AND GASOLINE OVERHEAD EQUIPMENT

12 months of operation at pH of 6.8-7.5 with NH_3 injection only.	12 months of operation at pH of 6.8-7.5 with NH_3 + 6 p.p.m. of organic amine inhibitor injection.	27 months of operation at low pH of 4.0-4.5 with small amount of ammonia injection + amine inhibitor injection rate at 12 p.p.m.
Carbon Steel		
General rate, 0.04 i.p.y.	General rate, 0.01 i.p.y.	General rate, 0.008 to 0.010 i.p.y.
Pitting depth, 0.07 i.p.y.	Pitting depth, 0.03 i.p.y.	Very mild general pitting.
Heavy scale on equipment plus heavy sludge deposits.	Light scale on equipment plus light sludge deposits.	Very light scale or film.
Inhibited Admiralty		
Severe pitting at condenser inlet only and general heavy attack under sludge deposits at rate of 0.06 i.p.y.	Severe pitting at condenser inlet at rate of 0.05 i.p.y. Moderate attack under sludge at rate of 0.025 i.p.y.	Very mild general over-all attack less than 0.01 i.p.y.
Stress cracking.	No cracking.	No cracking.

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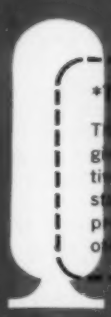

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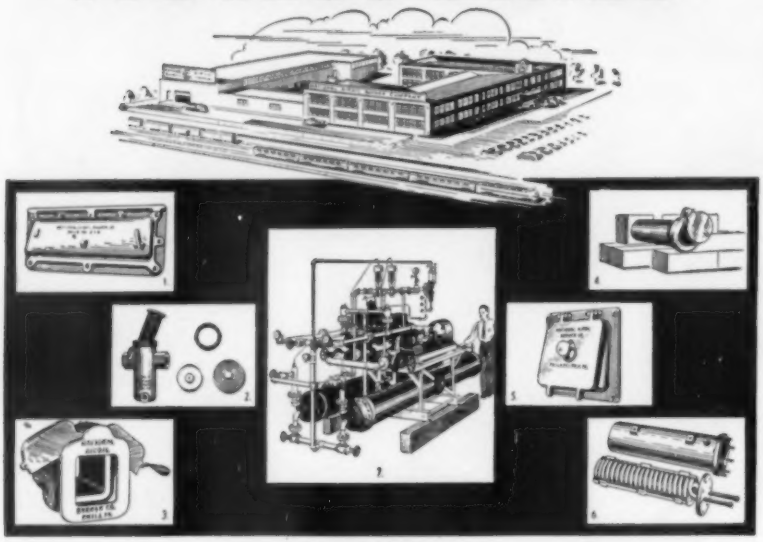

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pated. No equipment required replacement at this time because of corrosion damage.

Injection rates . . . Inasmuch as the process equipment was in excellent condition, the unit was again placed on stream after the shutdown and scheduled for 18 months of operation before the next turnaround. This period of operation was completed without any failures or plugging of equipment. During the summer of 1955, continuous inhibitor injection was started at the rate of 6 p.p.m. to the gasoline fractionator overhead.

The pH of reflux accumulator waters was then again slowly lowered to the range of 4.0 to 4.5, and the inhibitor injection rate was maintained at 9 p.p.m. This resulted in good protection, as shown by low iron and copper content in receiver waters and no continuous hydrogen probe activity.

Early in the spring of 1956 the raw-crude charge rate to the unit was slowly increased to 42,500 bbl. per day, and, within a short time, the hydrogen probes indicated a small pressure buildup and would not remain at zero after pressure bleedoff. The inhibitor injection rate was then increased to 15 p.p.m of total atmospheric overhead. After approximately 3 weeks, the probes would again remain at zero pressure after bleedoff as long as the average pH range remained at approximately 4.3, but they would show intermittent activity in the pH range of 3.7 to 4.1.

At the 1956 turnaround inspection, following the 18 months' operation at low pH levels, the equipment was again found to be in good condition. The unit was clean and showed a rather light, even protective film. A small amount of the film was removed by the representatives of the company which supplied the inhibitor, and the analysis indicated that good protection was being achieved.

Corrosion rates . . . The establishment of actual corrosion rates of equipment which has been in operation under different conditions and for various periods of time is rather difficult. Table 2 gives a summary of the relative corrosion rates, as nearly as could be determined, for the three different operations with (1) high pH and ammonia, (2) high pH and ammonia plus inhibitor, and (3) low pH and inhibitor.

When low-pH operation was first started, the pH of the desalter water effluent was increased to approximately 9.0 as it was felt that more acidic constituents in the crude oil would be removed during desalting.

Shortly after this increase, a severe coking of tubes was experienced in the delayed-coking furnace which was charged with vacuum-reduced crude-oil bottoms whose softening point was 75° F. A survey revealed that approximately 20 lb. of caustic soda per 1,000 bbl. was present in the coker charge.

The pH of the desalter was then reduced to 8.0, resulting in elimination of the coking-unit furnace deposits. At this lower pH, the coker charge contained an average of 2.0 lb. of caustic per 1,000 bbl.

Conclusions

1. The lower pH minimizes the ammonium-salt dissociation which would otherwise contribute to the complex corrosion problems and formation of iron and copper sulfides.

2. Clean equipment greatly reduces maintenance costs at scheduled turnarounds and also permits longer runs at increased charge rates.

3. It appears that if chlorides are neutralized with ammonia to a pH of 4.0 to 4.5, the inhibitor, at increased dosages, will provide a simple and effective surface film to protect the equipment from attack by hydrogen sulfide or other weak acids.

4. To a large extent, the quantity of inhibitor injection required for corrosion protection depends on velocities and flow rates.

5. When ammonia is injected only for chloride neutralization, ammonia contamination of all hydrocarbon streams is kept at a minimum.

6. The major portion of the hydrogen sulfide is retained in the hydrocarbon streams when operating at a lower pH level. This fact assists in the adoption of measures for pollution abatement.[7]

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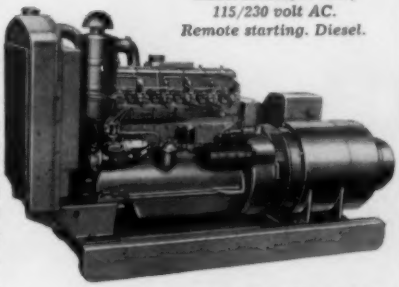

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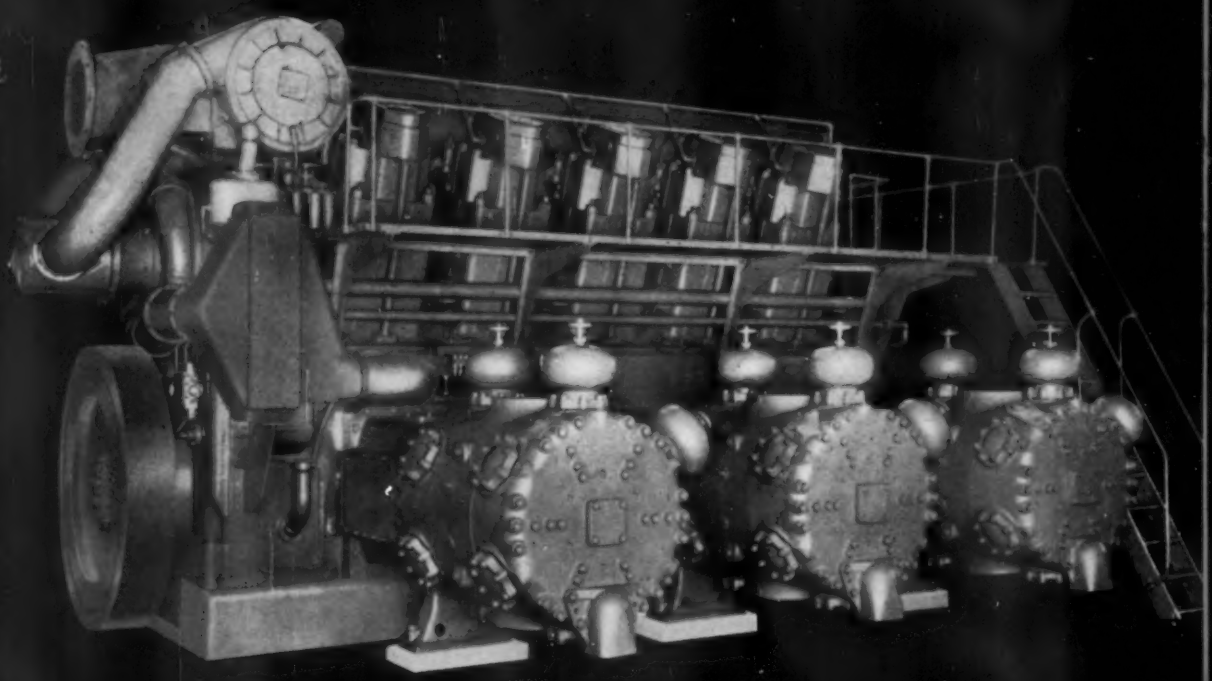

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by H. C. Nix

REGENERATIVE platinum-catalyst reforming was selected by Humble Oil & Refining Co. as a method for producing the high-octane components required in blending modern premium gasolines. Two 20,000-bbl. per stream day units were completed in the summer of 1955.

These units, best described as fixed-bed, regenerative catalytic reformers, utilize a platinum-on-alumina catalyst developed by Standard Oil Co. (Ind.). The regenerative feature of the catalyst permits operation at lower pressures, which results in higher gasoline yields than are produced in nonregenerative processes.

Humble reformers charge three narrow-cut fractions produced from a mixture of naphthas boiling from 200° to 370° F. These feeds are normally reformed to produce reformate of approximately 93 research octane number, clear, although reformate of 100 research octane number, clear, has been produced.

Author is with Humble Oil & Refining Co., Baytown, Tex. Paper presented at A.P.I. Refining Division meeting, Philadelphia, May 16, 1957, under the original title, "Regenerative Platinum-Catalyst Reforming."

The major problems have been sulfur and hydrogen sulfide corrosion and scale. Facilities to eliminate these difficulties will be installed shortly. Successful regeneration techniques have been developed which have maintained high catalyst activity. Catalyst life is now expected to be approximately 2 years.

The over-all operation of the platinum reformers has been satisfactory. Regenerative platinum-catalyst reforming has proved to be a successful method for producing modern premium gasolines.

Process description . . . Fresh naphtha and a hydrogen-rich recycle gas are heated and passed through several reaction and reheat stages. Because the reforming reactions are primarily endothermic, reheating of the reactants is required between the reactors.

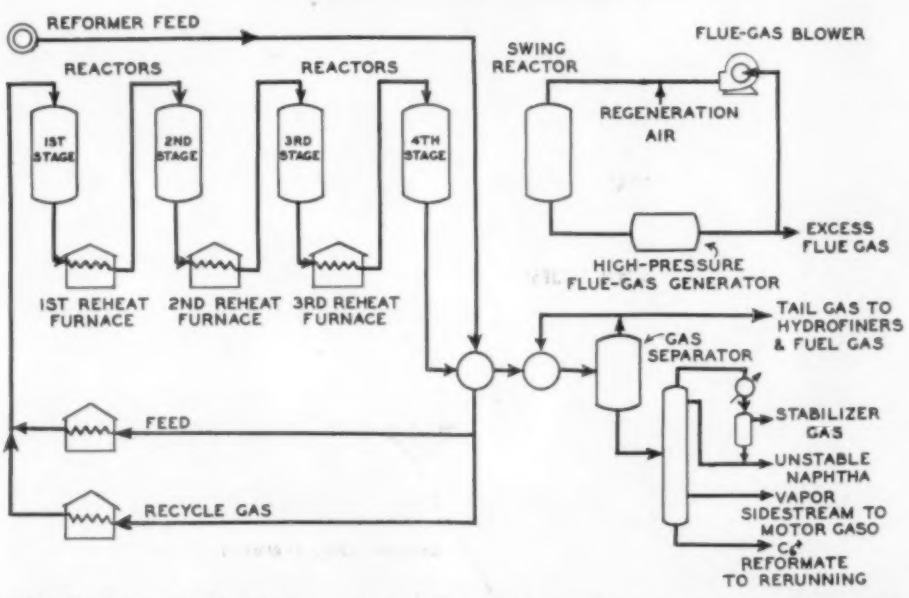
Naphthene dehydrogenation is the most highly endothermic reaction which occurs. Most of this reaction is completed in the first reactor. Therefore, a large temperature drop is experienced across the first reactor, with less temperature drop across each subsequent reactor.

The regenerative feature of the catalyst helps to make possible the following range of operating conditions:

1. Feed rate, bbl. per stream day . . 20,000
2. Recycle-gas ratio, std. cu. ft. per bbl. of fresh feed . . 3,500 to 6,000
3. Average reactor pressure, psig. . . . . 200 to 325
4. Reactor inlet temperature, °F. 840 to 960
5. Design product research octane number, clear 93
6. Ultimate product research octane number, clear . . . . . 100+

The previously mentioned typical reforming reactions occur, and the following products are formed:

1. A hydrogen-rich gas suitable for use in a hydrogen treater, or as a fuel gas.
2. Light hydrocarbons—propane, butanes, and pentanes.
3. A high-octane gasoline fraction, containing a small quantity of polymer which requires removal.



PROCESS FLOW in the Humble regenerative catalytic reforming processes is shown by this simplified diagram. Fig. 1.

The special regenerative feature of the platinum catalyst used makes possible low-pressure operations which result in higher yields for a given product octane number. As the low-pressure operations produce a greater amount of coke for a given severity, the catalyst deactivation is more rapid in this process than in higher-pressure (approximately 600 psig.), nonregenerative types of platinum reformers.

Inasmuch as the catalyst activity can be restored by a simple regeneration, high-severity operations are possible, and a lower recycle-gas ratio can be used. The long-term activity maintenance and strength characteristics of this catalyst make possible frequent regenerations, to maintain high activities and product yields.

Feed preparation . . . The reformer feed-preparation facilities are located at a separate unit. The virgin-naphtha pipe-still fraction from a mixture of Texas crude oils is, at present, partly desulfurized to approximately 100 p.p.m. of sulfur. It is then fractionated into three successive narrow cuts, boiling in the range from 200° to 370° F.

The lightest of these feeds, boiling from 200° F. to a final boiling point of 270° F., is charged preferentially to the converted hydroformer, which has a pressure limitation of approximately 250 psig. The other two feeds, boiling from 260° to 310° F. and 300° to 370° F., are charged in blocked operations to the new reformer.

This unit is capable of operating at approximately 325 psig. It is planned to install a hydrodesulfurization unit which will reduce the feed sulfur level to less than 25 p.p.m. The reasons for this change will be discussed later.

Reaction system . . . The reaction system consists of feed and recycle-gas preheat furnace, reheat furnaces, reactors, feed-reactor effluent heat exchangers, recycle-gas compressors, and a high-pressure separator.

A simplified flow diagram is presented in Fig. 1. Fresh feed is heated in the feed-reactor effluent exchangers and feed preheat furnace. It is then mixed with recycle gas which has been compressed and heated separately in the same way. The mixture of recycle gas and fresh feed goes through four reactors in series and a reheat furnace between each reactor.

The effluent from the last reactor exchanges heat with the fresh feed and recycle gas. It is cooled and flashed in a high-pressure separator. The recycle-gas compressors take suction from this separator, and the liquid product is ready for stabilization.

The pressure of the reaction is controlled by regulating the flow of the make gas from the separator. Currently, only three reaction stages are installed at the converted reformer. An additional reactor and reheat furnace will be installed this year.

Product recovery . . . The product-recovery system used in Humble's platinum reformers consists of a depentanizer which stabilizes the liquid product from the high-pressure separator. The unique feature of the depentanizing towers is that they are equipped to produce a vapor side stream at about three trays above the tower bottom. When it is desired to produce a stabilized reformate suitable for direct motor-gasoline blending, a side-stream cut is produced.

Approximately 80 per cent of the 430° F.+ polymer material which is normally in the reactor product is removed when the reformate is produced as a vapor side stream. Normally, most of the reformate from the company's reformers is fractionated in other units for production of aromatic solvents and blend components of aviation as well as motor gasoline. Complete polymer removal is accomplished in this operation.

Regeneration system . . . A common regeneration system is provided for the two reformers. The system is so designed that a reactor can be regenerated at one unit while a reactor is being prepared for regeneration or reaction at the other unit. Sizable time savings are thus achieved. A spare or swing reactor is provided at both reformers. Therefore, no interruption in oil processing occurs as a result of regeneration.

A high-pressure flue-gas generator supplies the unit gases used in regeneration. These gases are circulated with a flue-gas blower while the air requirements for regeneration are supplied by reciprocating compressors. A more detailed description of the regeneration operation will be presented later.

Special safety controls . . . In order to prevent the hazard of mixing regeneration gases and hydrocarbon vapors, the reactors are provided with double block valves and a seal-gas system. When a reactor is on reaction, the regeneration valves are closed and an elevated pressure maintained between the valves with an inert seal gas.

When a reactor is being regenerated, its hydrocarbon valves are closed in the same way. The seal-gas system is provided with flow, pressure, and temperature recorders and alarms. The double valve system is of supreme importance as it makes possible blinding off one reactor from service, for repairs or catalyst change, without affecting the rest of the unit.

The hydrocarbon valves for each reactor are motor-operated and push-button-controlled from the control room. One of the regeneration valves is motor-operated and the other is hand-operated. These valves are interlocked electrically to prevent errors in the sequence of valve operation.

TABLE 1—PLATINUM-REFORMER FEED INSPECTIONS

Feed nominal boiling range, °F.	200 to 270	260 to 310	300 to 370
A.S.T.M. distillation, °F.:			
Initial boiling point	210	272	306
5 per cent point	213	275	310
10 per cent point	216	277	312
20 per cent point	218	279	314
30 per cent point	220	280	316
40 per cent point	222	281	318
50 per cent point	224	282	321
60 per cent point	228	283	324
70 per cent point	232	285	328
80 per cent point	236	287	333
90 per cent point	245	290	341
95 per cent point	253	295	349
Final boiling point	278	318	371
Gravity, °A.P.I.	56.9	51.6	47.3
Hydrocarbon type, per cent by volume:			
Aromatics	10	16	19
Paraffins	42	41	39
Naphthenes	48	43	42
Olefins	0	0	0
Sulfur, p.p.m.	72	105	125
A.S.T.M. octane number (D 908, research method):			
Without TEL addition	61.5	54.0	53.0
With addition of 3 ml. TEL per gal.	80.4	73.6	72.9
A.S.T.M. octane number (D 357, motor method):			
Without TEL addition	60.0	52.7	53.2
With addition of 3 ml. TEL per gal.	80.0	72.9	72.9

Oxygen recorders are on the inlet and outlet regeneration gas stream, and each reactor is provided with temperature recorders for observing regeneration temperatures.

Feeds of three distinct boiling ranges are charged to the reformers in blocked operation. In this way, an optimum operating condition can be achieved for each feed. Table 1 presents typical feed-stock inspections. The feed stocks are desulfurized and fractionated at another unit and are stored in intermediate tankage.

Product yields . . . Typical product yields for each type of feed are presented in Table 2. The inspections on the debutanized product are presented in Table 3. These data are presented at two levels of severity for each feed. It will be noted that the data are presented for severities of 93 and 97 octane number for the two lighter feeds and 90 and 93 octane number for the heaviest feed.

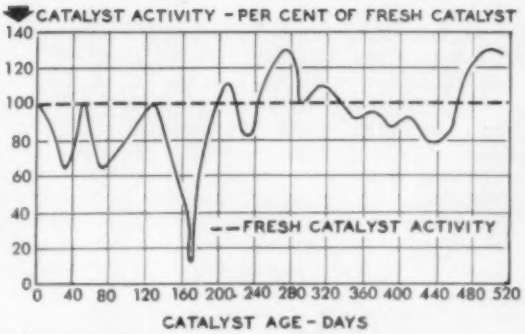
Inasmuch as coke production increases as the boiling range of the feed increases, the heaviest feed is usually not reformed as severely as the lighter feeds. The maximum severity attempted to date was 100 octane number when the feed with a final boiling point of 270° F. was charged. The stabilized reformate from this operation had a 103.8 research octane number, with the addition of 3 ml. TEL per gal.

Catalyst Deactivation

A platinum catalyst can be permanently poisoned by heavy metals such as molybdenum, arsenic, and lead. This is usually not a problem if the feeds are prepared as overhead distillates, as is now done by Humble. Careful sandblasting of the lines and equipment prevented molybdenum poisoning of the catalyst when the old molybdena reformer was converted for platinum.

Sulfur is a temporary platinum-catalyst poison. In order to prevent this effect, the reformer feed stocks were originally desulfurized to less than 200 p.p.m. of sulfur. Corrosion and scale considerations dictate a still lower sulfur level as will be discussed later.

Coke on the catalyst causes deactivation. However, the regeneration techniques employed by Humble have been very successful in burning off the coke from the catalyst, thereby restoring its activity.



CATALYST ACTIVITY in the Humble reformers varied according to the pattern over the first 500-plus days of operation. Fig. 2.

Catalyst activity . . . The activity maintenance of the catalyst used in Humble's platinum reformers has been exceptionally good. An average catalyst activity of 85 per cent of fresh catalyst has been achieved since the startup of the units. On one occasion the activity of the catalyst declined to as low as 10 per cent. However, regeneration techniques successfully restored the catalyst to the fresh level.

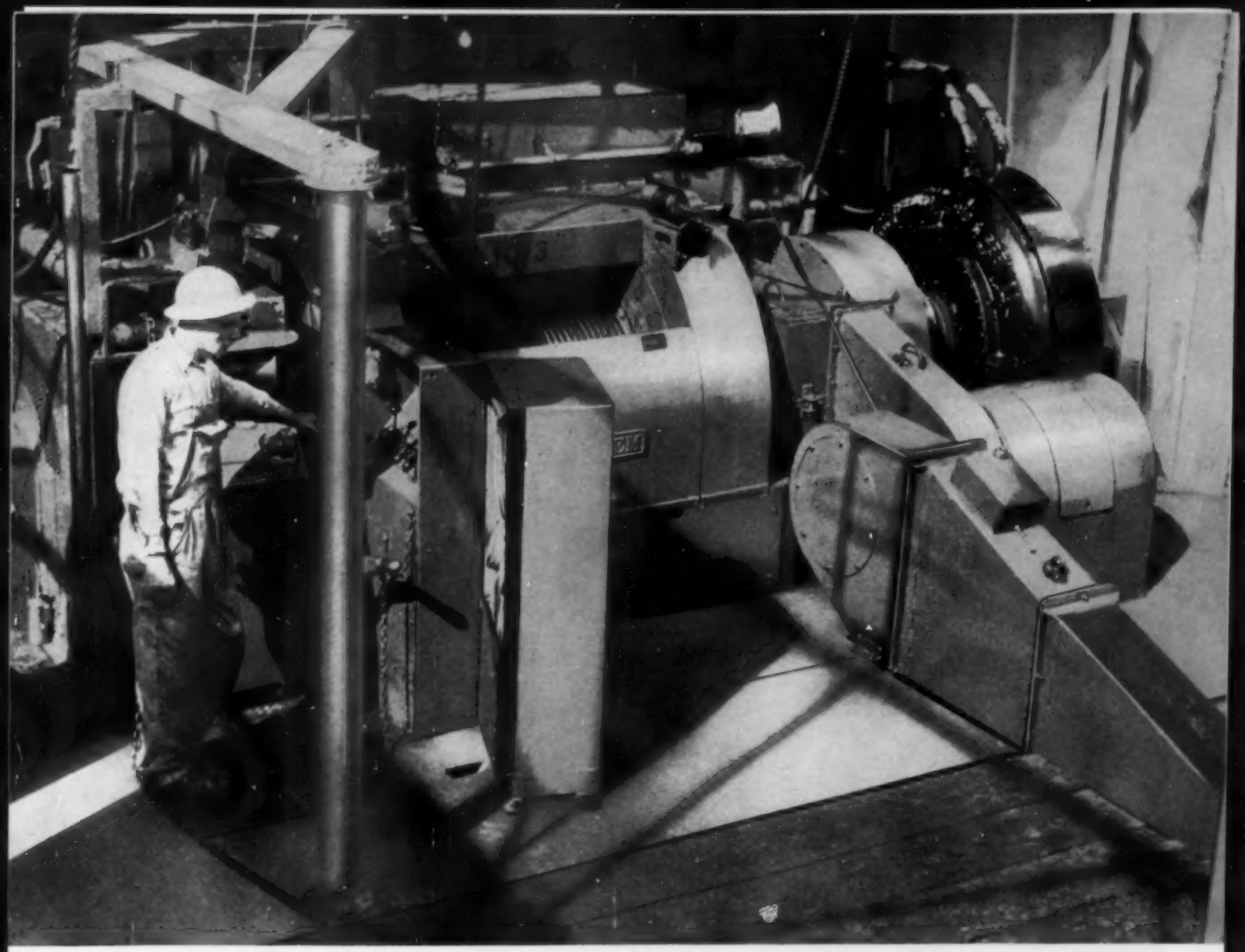
This extreme decline in catalyst activity was caused by insufficient regeneration and scale, which had partially plugged the catalyst beds. A

TABLE 3—INSPECTIONS ON DEBUTANIZED REFORMATE

Feed nominal boiling range, °F.	200 to 270		260 to 310		300 to 370	
A.S.T.M. octane No. (D 908, research method):						
Without TEL addition	93.0	97.0	93.0	97.0	90.0	93.0
Without addition of 3 ml. TEL per gal.	100.0	102.0	99.5	101.6	97.2	98.9
A.S.T.M. octane No. (D 357, motor method):						
Without TEL addition	82.9	86.4	82.8	86.3	80.4	82.7
With addition of 3 ml. TEL per gal.	92.0	94.7	91.1	93.8	88.2	90.0
Gravity, °A.P.I.	45.8	44.4	43.0	40.7	41.3	40.5
R.v.p., psi.	3.5	4.5	2.6	3.6	1.6	2.0
A.S.T.M. distillation, °F.:						
Initial boiling point	162	135	172	143	152	146
5 per cent point	199	187	220	200	215	210
10 per cent point	210	200	247	236	260	252
20 per cent point	219	214	262	257	290	285
30 per cent point	226	222	274	274	307	305
40 per cent point	230	228	282	284	318	315
50 per cent point	235	234	289	292	322	323
60 per cent point	240	239	294	298	328	329
70 per cent point	244	244	299	303	337	338
80 per cent point	254	254	307	310	344	346
90 per cent point	269	270	315	319	355	358
95 per cent point	283	287	323	328	375	379
Final boiling point	313	325	358	383	426	432
Hydrocarbon type, per cent by volume:						
Aromatics	59.5	65.0	59.9	70.6	55.5	62.0
Paraffins	37.0	33.0	36.5	26.0	34.5	31.5
Naphthenes	2.0	0.0	2.3	1.5	9.0	5.3
Olefins	1.5	2.0	1.3	1.9	1.0	1.2

TABLE 2—PLATINUM-REFORMER PRODUCT YIELDS

Feed nominal boiling range, °F.	200 to 270				260 to 310				300 to 370			
C_5+ product octane number	93 Yield, %		97 Yield, %		93 Yield, %		97 Yield, %		90 Yield, %		93 Yield, %	
Product:	Vol.	Wt.	Vol.	Wt.	Vol.	Wt.	Vol.	Wt.	Vol.	Wt.	Vol.	Wt.
H_2	....	2.3	....	2.5	....	1.0	....	2.0	....	1.5	....	1.7
C_1	....	0.6	....	1.0	....	0.6	....	0.9	....	0.3	....	0.4
C_2	....	1.3	....	2.1	....	1.2	....	2.0	....	0.6	....	0.9
C_3	....	2.5	....	4.0	....	2.3	....	3.7	....	1.1	....	1.7
C_4	5.0	3.8	8.0	6.1	4.6	3.5	7.5	5.6	2.3	1.7	3.5	2.6
C_5	5.0	4.2	8.0	6.7	4.6	3.7	7.5	6.1	2.3	1.8	3.5	2.8
C_6+	80.8	85.3	73.4	77.6	82.0	86.8	74.7	79.7	88.4	93.0	84.9	89.9
		100.0		100.0		100.0		100.0		100.0		100.0



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plot of the catalyst activity for the new unit is shown in Fig. 2.

The catalyst in one reactor has now achieved a life of approximately 60 bbl. of feed per pound of catalyst, with no indication of permanent activity decline. The oldest catalyst in the units has been on oil 450 days to date. An ultimate life of at least 2 years is now anticipated.

Regeneration . . . The platinum catalyst is reactivated by the process of regeneration. The reactor which is to be regenerated is replaced in the reaction sequence by the swing reactor, it is purged of heavy hydrocarbons with recycle gas, and it then receives an inert-gas purge. After purging, a flue gas containing approximately 2 per cent of oxygen is passed over the catalyst at a temperature between 800° and 1,050° F.

When the coke burn is completed, the reactor is purged with inert flue gas, followed by a recycle-gas purge, and is placed back on reaction. The double block valve and seal-gas system is operated during regeneration, as previously discussed. Each reactor is regenerated at about 6-day intervals. Generally, approximately 0.5 to 1.5 per cent by weight of coke is burned during each regeneration.

Corrosion and scale . . . The principal difficulties encountered in the operation of Humble's platinum reformers have been caused by sulfur and hydrogen sulfide corrosion of the hydrocarbon piping, which has resulted in metal loss and scale formation. Sulfur corrosion rates of 200 mils per year were experienced in the carbon-½ per cent molybdenum tubes of the naphtha preheat furnace at the new reformer.

This furnace has since been retubed with 9 per cent chrome-1 per cent molybdenum tubes. Hydrogen sulfide corrosion rates of approximately 60 to 90 mils per year have been experienced in the low-chrome molybdenum reheat tubes and transfer lines at this same unit. No corrosion was found in the 18 per cent chrome-8 per cent nickel tubes in the converted reformer. However, the same experience was obtained with low-chrome molybdenum metals as at the new unit.

In addition to the problem of metal loss, the scale flakes off the furnace tubes and transfer lines and plugs up the catalyst beds. The result is high-pressure drop and poor catalyst-bed distribution, which reduces the effectiveness of the catalyst.

Because the reformers are equipped with double block valves, it has been possible to blind off a reactor, and to dump and screen the catalyst. The catalyst is reloaded, and activity is restored by regeneration. The permanent solution to the problem of corrosion and scale will be the installation of a hydrodesulfurization unit designed to reduce the sulfur levels of the reformer feed to less than 25 p.p.m.

Other problems . . . Among the other problems encountered in the operation of the reformers has been the coking of feed heat exchangers. This was caused by upset of the gas-blanketing system on the reformer feed tankage. The purpose of the gas blanket is to prevent oxygen from being absorbed into the feed.

Dissolved oxygen can result in exchanger coking and fouling at the point in the system where the naphtha becomes entirely vaporized. Early in the operation of the units, catalyst attrition resulted from the high velocity of the vapor entering into the reactors. New reactor entrance baffles have eliminated this problem. **End.**

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Tests shed new light on

Pipeline Pressure-Surge Problems

"Electronic-computer techniques could be applied and would greatly facilitate the preparation of much of the material in chart and graph form . . . and lessen the computation effort required in the analysis of many pressure-surge problems."

by Robert D. Kersten and Edwin J. Waller

Part 2 of Two Parts

THE test station was equipped with four double-acting duplex Gaso pumps with V-belt drive. Crude oil is pumped from tankage through approximately 45 miles of 8-in. line into tankage. There are several diameter changes and short stub lines involved.

Instrumentation . . . Fluctuating pressures were measured and recorded with the aid of Consolidated Engineering Corp. and Baldwin pressure cells. The output of the cells was fed into a Midwestern recording oscillograph. The measured values of pressure recorded in Tables 2 through 7 were obtained from the analysis of the oscillograph traces. Brown recording pressure gages were used to measure the mean discharge pressures at the sending and receiving ends.

Crude-oil data . . . Samples of crude oil were taken before, during, and after the test runs. Analysis of the samples gave the following data:

Density 40.7° A.P.I. at 54° F. or 1.59 slugs per cu. ft.

Viscosity 51.5 S.U.s. or 13.45 × 10^{5} lb.-sec. per sq. ft.

Velocity of Propagation . . . The velocity of propagation of pressure waves in the system was determined by measuring the time required for a down surge to travel from the sending-end pumps to the receiving end. An average time of travel of 59.3 seconds was used, giving a velocity of propagation of 4,029 ft. per second.

Determination of the attenuation coefficient . . . The attenuation coefficient may be readily determined from Equation 5. Pertinent data are tabulated in Table 1. The mean pressure drop was plotted against the mean velocity and a value of 1.75 determined for n. The resulting values of the attenuation coefficient were small enough to be ignored in the analysis of the test station piping.

Analysis . . . With the distance, x, measured from the receiving end, the pressure and volume current for any end termination, Z_r, are given by Equations 1 and 2.

With αx small (i.e., Cosh $\alpha x \sim 1$ and Sinh $\alpha x \sim 0$), Equations 1 and 2 reduce to:

$$P_x = P_r \cos \beta x + j\, Q_r\, Z_c \sin \beta x \quad (14)$$

and

$$Q_x = Z_r \cos \beta x + j\, (P_r/Z_c) \sin \beta x \quad (15)$$

At the receiving end:

$$P_r = Q_r\, Z_r \quad (16)$$

Letting x = l, the sending-end impedance becomes:

$$Z_s = Z_c \frac{Z_r + j\, Z_c \tan \beta l}{Z_c + j\, Z_r \tan \beta l} = P_s/Q_s \quad (17)$$

With the distance, x, measured from the sending end, the pressure and volume current for any end termination, Z_s, are given as:

$$P_x = P_s \cosh \gamma x - Q_s\, Z_c \sinh \gamma x \quad (18)$$

and

$$Q_x = Q_s \cosh \gamma x - (P_s/Z_c) \sinh \gamma x \quad (19)$$

Again, when αx is small (i.e., Cosh $\alpha x \sim 1$ and Sinh $\alpha x \sim 0$), Equations 18 and 19 reduce to:

$$P_x = P_s \cos \beta x - j\, Q_s\, Z_c \sin \beta x \quad (20)$$

and

$$Q_x = Q_s \cos \beta x - j\, (P_s/Z_c) \sin \beta x \quad (21)$$

Letting x = l and:

$$P_s = Z_s\, Q_s \quad (22)$$

the receiving-end impedance, Z_r, becomes:

$$Z_r = Z_c \frac{Z_s - j\, Z_c \tan \beta l}{Z_c - j\, Z_s \tan \beta l} \quad (23)$$

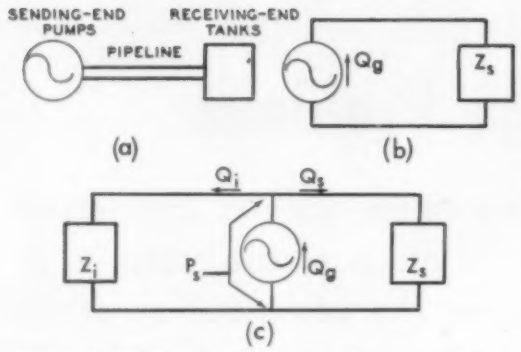
PIPELINING

TABLE 1—DATA FOR DETERMINATION OF n AND α

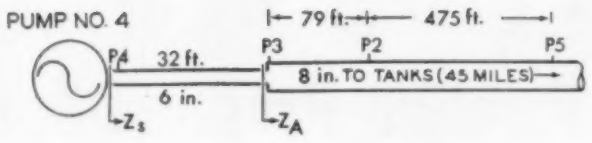
Test No.	q cu. ft./sec.	U ft./sec.	PS* (psi.)	PR* (psi.)	PS-PR (psi.)	p† (psi.)	αx 10^{-6} numeric per ft.	N_R $\times 10^{-4}$
1	0.797	2.29	111.0	...	...	...	9.339	1.800
2	0.847	2.44	138.0	8.3	129.7	289.5	9.945	1.920
3	0.687	1.98	67.0	7.5	59.5	219.3	8.309	1.558
4	0.612	1.76	60.0	7.3	52.7	212.5	7.712	1.383
5	0.787	2.27	90.0	7.5	82.5	242.3	9.241	1.785
6	0.870	2.50	148.0	8.5	139.5	299.3	10.036	1.965

*PS = mean pressure as shown by recorder at the sending end; PR = mean pressure as shown by recorder at the receiving end. p = PS less PR plus effects of elevation change between stations.

Robert D. Kersten is research engineer, Carter Oil Co., Tulsa, and Edwin J. Waller is associate professor of civil engineering, Oklahoma A. & M., Stillwater.



ANALYSIS SKETCHES of field-test pipeline system. Fig. 3.



EQUIPMENT ARRANGEMENT in one-pump tests with pump at end of line. Fig. 4.

The field-test pipeline system was basically composed of pumps, pipeline, and receiving-end tank, as shown in Fig. 3a.

Electrically, this system may be diagramed as shown in Fig. 3b. Analysis of the system based on this arrangement gave pressure magnitudes in good agreement with measured values. However, the resulting phase angles were generally not in good agreement with measured values.

The concept of treating the pump as a constant current generator (electrically speaking) was then introduced. That is, the pump was thought of as having an internal impedance, Z_i, in parallel and generating a volume current, Q_g, which divides—part, Q_i, circulating through the internal impedance and the remainder, Q_s, flowing out into the pipeline system proper. See Fig. 3c.

Then:

$$P_s = Z_s Q_s = Z_i Q_i = Z_p Q_g \quad (24)$$

and

$$Q_g = Q_i + Q_s \quad (25)$$

From Equations 24 and 25:

$$Z_p = \frac{Z_i Q_i}{Q_g} = \frac{Z_i Q_i}{Q_i + Q_s}$$

$$= \frac{Z_i Z_s}{Z_i + Z_s} \quad (26)$$

or

$$Z_i = \frac{Z_p Z_s}{Z_s - Z_p} \quad (27)$$

The sending-end impedance, Z_s, may be readily calculated from Equation 17. The measurement of P_s permits calculation of Q_s from Equation 24. Knowing Q_s and Q_g (from pump equation), Q_i may be easily determined from Equation 25. With the values of Q_i and Q_g known, the values of Z_i and Z_p may be established from Equation 24 or Equations 26 and 27.

If P_s and Z_s are known, the values of Q_s may be calculated. It is not necessary to determine the value of Z_i in order to proceed with the analysis.

However, if P_s is now known, it becomes necessary to evaluate Z_i by some means. This, in turn, permits evaluation of Z_p (impedance at the pump) by use of Equation 26. Then, the sending-end pressure value, P_s, may be calculated from Equation 24.

TABLE 2—TEST NO. 1*
Comparison of Measured and Calculated Pressure Values

	P4 (at pump) measured		Q_s (at pump) calculated	
Harmonic	Psi.	$\phi°$	Cu. ft./sec.	$\phi°$
1	12.62	−90.0	0.0980	−85.8
3	6.46	+145.8	0.0481	+133.5
4	16.46	−90.0	0.1187	−105.4
8	5.18	−104.1	0.0304	−130.5
Prms.	15.79			

	P3 (x_3 = 32 ft.)			
	Calculated		Measured	
Harmonic	Psi.	$\phi°$	Psi.	$\phi°$
1	12.77	−96.2	12.50	−100.5
3	6.23	+127.1	5.11	+122.2
4	16.72	−113.6	15.33	−118.6
8	4.26	−148.2	5.17	−150.4
Prms.	15.80		14.90	

	P2 (x = 111 ft.)			
	Calculated		Measured	
Harmonic	Psi.	$\phi°$	Psi.	$\phi°$
1	12.76	−105.2	11.44	−106.4
3	6.23	+99.8	4.97	+90.0
4	16.25	−148.2	15.61	−156.8
8	4.40	+138.0	4.80	+143.8
Prms.	15.58		14.54	

	P5 (x = 554 ft.)			
	Calculated		Measured	
Harmonic	Psi.	$\phi°$	Psi.	$\phi°$
1	12.60	−159.7	9.89	−161.1
3	6.23	−115.6	4.95	−92.6
4	15.57	−8.4	12.27	−27.6
8	4.25	+2.6	4.12	+33.7
Prms.	15.13		12.04	

*Pump No. 4 at 77.4 r.p.m.

In the case of the field tests, P_s, was a known (measured) quantity. It was then possible to calculate Q_s and, hence, values of pressure and volume current at other points in the system.

One-pump tests with pump at end of line . . . The physical arrangement of the equipment was as shown in Fig. 4. Points P2, P3, etc., denote locations of pressure pickups.

Three tests (Nos. 1, 2, and 3) at 66.7, 77.4, and 82.2 r.p.m. were run using this setup. The circuit may be visualized electrically as shown in Fig. 3.

Applying the equations and techniques outlined in the previous section, the pressures at the various pickup points were calculated. Measured

TABLE 3—TEST NO. 2*
Comparison of Measured and Calculated Pressure Values

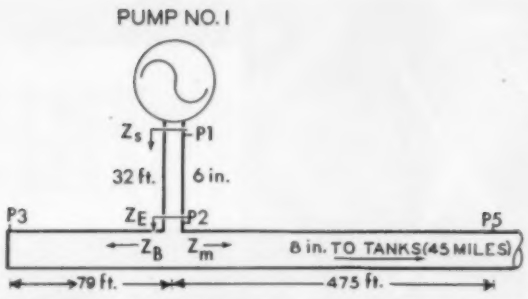
	P4 (at pump) measured		Q_s (at pump) calculated	
Harmonic	Psi.	$\phi°$	Cu. ft./sec.	$\phi°$
1	12.73	−94.7	0.0988	−99.1
3	7.17	+140.4	0.0529	+127.5
4	15.86	−84.3	0.1129	−101.0
8	5.15	−103.4	0.0293	−130.5
Prms.	15.68			

	P3 (x = 32 ft.)			
	Calculated		Measured	
Harmonic	Psi.	$\phi°$	Psi.	$\phi°$
1	12.67	−101.4	12.39	−98.8
3	6.70	+125.2	6.55	+117.2
4	14.82	−110.2	15.17	−118.6
8	4.15	−153.4	5.72	−155.7
Prms.	14.87		15.15	

	P2 (x = 111 ft.)			
	Calculated		Measured	
Harmonic	Psi.	$\phi°$	Psi.	$\phi°$
1	12.68	−111.1	12.66	−108.7
3	6.70	+96.2	6.82	+91.3
4	14.82	−148.9	13.12	−151.6
8	4.15	+129.2	5.09	+128.6
Prms.	14.87		14.23	

	P5 (x = 554 ft.)			
	Calculated		Measured	
Harmonic	Psi.	$\phi°$	Psi.	$\phi°$
1	12.67	−169.2	10.97	−169.9
3	6.70	−78.2	5.94	−102.8
4	14.67	−21.4	14.46	−42.9
8	4.15	+24.2	3.71	+7.4
Prms.	14.79		13.76	

*Pump No. 4 at 82.2 r.p.m.



EQUIPMENT ARRANGEMENT in one-pump tests with pump not at end of line. Fig. 5.

and calculated values are compared in Tables 2, 3, and 4.

One-pump tests (with pump not at end of line): The physical arrangement of the equipment was as shown in Fig. 5.

Three tests (Nos. 4, 5, and 6) at 59.4, 76.4, and 84.5 r.p.m. were run using this setup. The circuit may be visualized electrically as shown in Fig. 3. However, Z_m in this case is the parallel combination of the long line and the short stub in series with the short 6-in. line.

Again, applying the equation and techniques previously outlined, the pressures at the various pickup points were calculated. Measured and calculated pressure values are compared in Tables 5, 6, and 7.

Analysis of test results . . . There were six one-pump tests. The oscillograph traces were analyzed for the first, third, fourth, and eighth harmonics at three different points in the pipeline.

In order for the theory to predict accurately the experimental pressure, the difference Y between the observed pressure and theoretical pressure, when analyzed statistically, must have reasonable values when compared to the precision of measurement. The differences $Y = P_{th} - P_{exp}$ are recorded in Table 8.

When these 72 values are analyzed, it is found that:

1. Y is normally distributed with mean, $\bar{Y} = -0.15$ psi. $= 0$.

2. The standard deviation $= [(Y_i - \bar{Y})^2/72]^{1/2} = 1.33$ psi.

3. Therefore, with 95 per cent confidence (i.e., 19-1 odds), the experimental pressure amplitudes are predicted by the theory within 2.66 psi. (two standard deviations) of the theoretical pressure, without regard to the precision of measurement. It is noted that only one measurement differed by more than ± 4 psi. and only eight by more than ± 2 psi. (See Table 8.)

When considering that the factors that comprise the error of measurement alone might be as much as ± 4.32 psi., one can only conclude the fundamental principles and theory satisfactorily predict measured pressures within limits of instrumentation.

In comparing the root mean square (square root of one-half the sum of the squares) pressure values, it was found that none of the 18 values exceeded the probable error of ± 4.32 psi. (See Table 9.)

Conclusions and Recommendations

The results of the work related herein adequately account for the pressure fluctuations in a reciprocating pump system. Specifically:

1. The validity of the basic under-

TABLE 4—TEST NO. 3*
Comparison of Measured and Calculated Pressure Values

	P4 (at pump) measured		Q_s (at pump) calculated	
Harmonic	Psi.	$\phi°$	Cu. ft./sec.	$\phi°$
1	12.22	−115.9	0.0950	−119.8
3	5.95	+153.5	0.0448	+142.8
4	13.13	−83.4	0.0963	−97.4
8	4.95	−79.1	0.0310	−103.2
Prms.	13.82	....	.....	....

	P3 (x = 32 ft.)			
	Calculated		Measured	
Harmonic	Psi.	$\phi°$	Psi.	$\phi°$
1	12.17	−121.4	13.05	−118.8
3	5.80	+137.2	5.50	+143.6
4	12.52	−104.7	13.55	−106.2
8	4.23	−118.6	4.50	−120.4
Prms.	13.35	....	14.22	....

	P2 (x = 111 ft.)			
	Calculated		Measured	
Harmonic	Psi.	$\phi°$	Psi.	$\phi°$
1	12.17	−129.2	13.76	−124.2
3	5.80	+113.7	5.84	+111.5
4	12.53	−136.1	15.32	−136.7
8	4.23	+178.6	4.39	+169.7
Prms.	13.35	....	15.45	....

	P5 (x = 554 ft.)			
	Calculated		Measured	
Harmonic	Psi.	$\phi°$	Psi.	$\phi°$
1	12.17	−176.4	12.17	−151.2
3	5.80	−27.8	5.71	−50.5
4	12.52	+35.3	12.40	+24.8
8	4.23	+161.4	4.00	+133.5
Prms.	13.35	....	13.24	....

*Pump No. 4 at 66.7 r.p.m.

TABLE 5—TEST NO. 4*
Comparison of Measured and Calculated Pressure Values

	P1 (at pump) measured		Q_s (at pump) calculated	
Harmonic	Psi.	$\phi°$	Cu. ft./sec.	$\phi°$
1	8.70	−90.0	0.0687	−90.0
3	4.18	+117.5	0.0378	+126.6
4	8.54	−106.5	0.0920	−95.6
8	1.40	−56.3	0.0312	−98.9
Prms.	9.16	....	.....	....

	P2 (x = 32 ft.)			
	Calculated		Measured	
Harmonic	Psi.	$\phi°$	Psi.	$\phi°$
1	8.72	−94.9	8.61	−91.4
3	5.28	+123.4	4.20	+99.6
4	9.94	−129.8	10.23	−130.6
8	2.03	−160.9	1.79	−166.9
Prms.	10.17	....	9.99	....

	P3 (x = 111 ft.)			
	Calculated		Measured	
Harmonic	Psi.	$\phi°$	Psi.	$\phi°$
1	8.80	−94.4	8.94	−95.2
3	5.70	+123.4	4.62	+101.8
4	11.41	−129.8	12.17	−128.7
8	3.90	−160.4	3.72	−159.9
Prms.	11.30	....	11.47	....

	P5 (x = 507 ft.)			
	Calculated		Measured	
Harmonic	Psi.	$\phi°$	Psi.	$\phi°$
1	8.68	−136.4	7.89	−140.4
3	5.30	−2.6	3.19	−49.4
4	9.94	+62.2	8.86	+54.5
8	2.07	−184.8	1.86	−162.1
Prms.	10.16	....	8.78	....

*Pump No. 1 at 59.4 r.p.m.

TABLE 6—TEST NO. 5*
Comparison of Measured and Calculated Pressure Values

	P1 (at pump) measured		Q_s (at pump) calculated	
Harmonic	Psi.	$\phi°$	Cu. ft./sec.	$\phi°$
1	11.92	−131.2	0.0962	−126.2
3	3.77	+136.2	0.0395	+146.6
4	7.21	−108.4	0.0969	−100.2
8	4.10	−21.4	0.0472	−106.0
Prms.	10.60	....	.....	....

	P2 (x = 32 ft.)			
	Calculated		Measured	
Harmonic	Psi.	$\phi°$	Psi.	$\phi°$
1	12.09	−137.6	12.48	−141.0
3	4.32	+114.1	4.39	+74.8
4	9.27	−143.7	12.83	−161.3
8	1.59	+176.3	1.14	+146.0
Prms.	11.26	....	13.05	....

	P3 (x = 111 ft.)			
	Calculated		Measured	
Harmonic	Psi.	$\phi°$	Psi.	$\phi°$
1	12.25	−137.6	13.72	−133.5
3	4.91	+114.1	5.28	+87.2
4	11.73	−143.7	16.67	−148.6
8	6.48	+176.3	6.28	+163.3
Prms.	13.30	....	16.33	....

	P5 (x = 507 ft.)			
	Calculated		Measured	
Harmonic	Psi.	$\phi°$	Psi.	$\phi°$
1	12.09	−191.6	12.74	−174.2
3	4.32	−47.9	3.77	−101.6
4	9.27	+0.2	9.77	−24.5
8	1.59	+104.1	5.09	+85.5
Prms.	11.25	....	11.97	....

*Pump No. 1 at 76.4 r.p.m.

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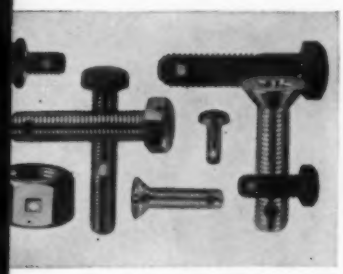

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lying derivations has been established.

(a) The fundamental principles and equations formulated in the basic theoretical analysis have been verified.

(b) The principle of superposition is applicable to this situation.

(c) Simplification of the general mathematical expressions is valid for this case.

2. The applicability of the fundamental principles to a field-scale system has been demonstrated.

(a) The techniques of analysis were successfully applied to an actual field installation.

(b) It appears that the use of these results will be limited only by the ingenuity of the persons performing the analysis.

(c) The results of this work are general enough in nature to permit the designer to apply them to a variety of piping configurations with a high degree of confidence.

The parameters based on the concepts of the hydraulic-electric analogy have been reasonably well established. Although work should be continued on the study of these basic parameters, the main effort should be directed toward further development of techniques of analysis for more complex pipeline systems.

The basic theme of this entire research activity is the hydraulic electric analogy. This being the case, electronic computer techniques could be applied and would greatly facilitate the preparation of much of the material in chart and graph form. Such procedures could lessen considerably the computation effort required in the analysis of many pressure surge problems.

TABLE 7—TEST NO. 6*

Comparison of Measured and Calculated Pressure Values

	P1 (at pump) measured		Q_s (at pump) calculated	
Harmonic	Psi.	$\phi°$	Cu. ft./sec.	$\phi°$
1	7.87	−114.9	0.0639	−109.4
3	3.88	+115.7	0.0437	+126.3
4	7.59	−104.3	0.1159	−99.8
8	7.82	−42.6	0.0629	−131.6
Prms.	9.89			

P2 (x = 32 ft.)

	Calculated		Measured	
Harmonic	Psi.	$\phi°$	Psi.	$\phi°$
1	8.01	−122.0	8.21	−125.9
3	4.62	+90.2	5.90	+97.2
4	10.59	−146.4	12.14	−142.7
8	0.83	+146.4	0.23	−135.0
Prms.	9.96		11.20	

P3 (x = 111 ft.)

	Calculated		Measured	
Harmonic	Psi.	$\phi°$	Psi.	$\phi°$
1	8.15	−122.0	9.61	−131.7
3	5.40	+90.2	6.78	+94.8
4	14.18	−146.4	15.39	−146.2
8	7.38	+146.4	7.94	+152.9
Prms.	13.25		14.80	

P5 (x = 507 ft.)

	Calculated		Measured	
Harmonic	Psi.	$\phi°$	Psi.	$\phi°$
1	8.01	−181.2	10.40	−178.1
3	4.61	−89.5	4.69	−99.9
4	10.59	−25.4	9.94	−20.4
8	0.83	+28.4	0.51	−35.5
Prms.	9.96		10.71	

*Pump No. 1 at 84.5 r.p.m.

TABLE 8—DIFFERENCE BETWEEN MEASURED AND CALCULATED PRESSURE VALUES FOR EACH HARMONIC

Test	Pickup	Harmonic	Y difference psi.*
1	3	1	+0.27
		3	+1.12
		4	+1.39
		8	−0.91
1	2	1	+1.32
		3	−1.26
		4	+0.64
		8	−0.40
1	5	1	+2.71
		3	+1.28
		4	+3.30
		8	+0.13
2	3	1	+0.29
		3	+0.15
		4	−0.35
		8	−1.57
2	2	1	+0.02
		3	−0.12
		4	+1.70
		8	−0.94
2	5	1	+1.70
		3	+0.76
		4	+0.21
		8	+0.44
3	3	1	−0.88
		3	+0.30
		4	−1.03
		8	−0.27
3	2	1	−1.59
		3	−0.04
		4	−2.79
		8	−0.16
3	5	1	...
		3	+0.09
		4	+0.12
		8	+0.23
4	2	1	+0.11
		3	+1.08
		4	−0.29
		8	+0.24
4	3	1	−0.14
		3	+1.08
		4	−0.76
		8	+0.18
4	5	1	+0.79
		3	+2.11
		4	+1.08
		8	+0.21
5	2	1	−0.39
		3	−0.07
		4	−3.56
		8	+0.45
5	3	1	−1.47
		3	−0.31
		4	−4.94
		8	+0.20
5	5	1	−0.65
		3	+0.55
		4	−0.50
		8	−3.50
6	2	1	+0.20
		3	−1.28
		4	−1.55
		8	+0.60
6	3	1	−1.46
		3	−1.38
		4	−1.21
		8	−0.56
6	5	1	−2.39
		3	−0.08
		4	+0.65
		8	+0.32

*Plus indicates calculated value greatest.

TABLE 9

Comparison of Measured and Calculated Root Mean Square Pressure Values

Test No.	Pickup No.	Calculated prms. (psi.)	Measured prms. (psi.)	Difference psi.*
1	3	15.80	14.90	+0.90
1	2	15.58	14.54	+1.04
1	5	15.13	12.04	+3.09
2	3	14.87	15.15	−0.28
2	2	14.87	14.23	+0.64
2	5	14.79	13.76	+1.03
3	3	13.35	14.22	−0.87
3	2	13.35	15.45	−2.10
3	5	13.35	13.24	+0.11
4	2	10.17	9.99	+0.18
4	3	11.30	11.47	−0.17
4	5	10.36	8.78	+1.38
5	2	11.26	13.05	−1.79
5	3	13.30	16.33	−3.03
5	5	11.25	11.97	−0.72
6	2	9.96	11.20	−1.24
6	3	13.25	14.80	−1.55
6	5	9.96	10.71	−0.75

*Plus indicates calculated value greater.

Acknowledgments

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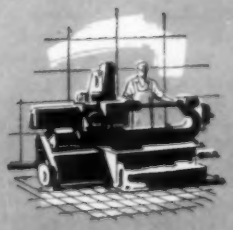

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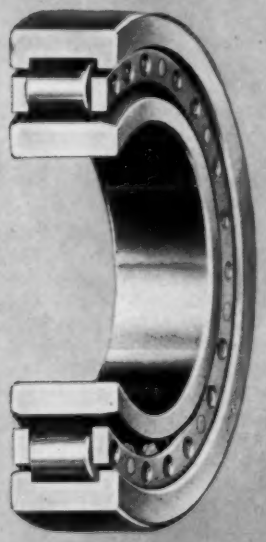

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How 31 Companies Are Fighting Corrosion in Cat Reforming

THE TROUBLES . . .

Excessive metal loss
Heavy scaling of furnace tubes
Plugging of catalyst beds
Fouling of heater and exchanger tubes

THE WEAPONS . . .

Proper alloying—18-8 Cr-Ni stainless
Feed-stock desulfurization
H_2S removal in recycle gas
Aluminizing

by E. B. Backensto

A SURVEY of 31 companies, representing experience on all types of commercial catalytic reforming units and desulfurizers which use hydrogen, revealed that the most frequently encountered difficulties related to corrosion were excessive metal loss; heavy scaling of furnace tubes, exchangers, and/or transfer lines; plugging of catalyst beds; and fouling of heater and exchanger tubes.

The most widely used methods to combat and/or control corrosion are proper alloying, generally with 18-8 chromium-nickel stainless steel at high temperature; feed-stock desulfurization; hydrogen sulfide removal from recycle gas; and aluminizing.

Without exception, all companies stated that their corrosion experience with catalytic reformers agreed generally with that described in recent literature.

Corrosion scale . . . In most of the modern processes a platinum-type catalyst is used. With these catalysts, the sulfur is transformed to hydrogen sulfide and appears in the hydrogen-rich recycle gas stream. In several catalytic reformers large volumes of corrosion scale (iron sulfide) became a serious problem; unexpectedly high corrosion rates were also found.

While the literature indicated the possible seriousness of corrosion by hydrogen sulfide, the available data were not directly applicable to catalytic reforming conditions.

The first data on corrosion rates under simulated reforming conditions were reported in October 1955.[1] This report proposed the following three general methods for minimizing corrosion by hydrogen sulfide: (1) reduction of hydrogen sulfide in process streams; (2) use of chromium-nickel austenitic steels; and (3) protection of steels by aluminizing.

In the year that followed, 1956, a considerable amount of information on this subject appeared in the literature. The paper by Sorell and Hoyt[2] contains an excellent bibliography and is a thorough collection of data on corrosion by hydrogen sulfide as related to catalytic reforming.

Materials of construction, inspection reports, and corrosion experiences for the following reforming and associated processes can now be found in the literature: Autofiner,[2] Catformer,[2 9] Platformer,[2 17] Platinum-Catalyst Reformer,[11] Sinclair-Baker,[2 5 7 8 14] Sovaformer,[4] Thermofor Catalytic Reformer,[3] and Ultraformer.[2 6] Correlation charts which can be used for the selection of construction materials have been presented.[1 2 3 4 6 9 12 13 14] The types of plot and the slopes of the isocorrosion rate curves differ somewhat, but all charts will produce the same general conclusions. Theories for the corrosion mechanism for hydrogen sulfide in a hydrogen-rich atmosphere have been proposed recently.[11 12 14 15] While field results with the various types of aluminizing are still meager, reference is made to experiences with aluminizing in several recent articles.[1 2 3 4 10 14]

This is a summary report of the A.P.I. panel on reformer corrosion. Author, who is chairman of the panel, is with Socony Mobil Oil Co., Paulsboro, N. J. Other panel members: W. A. McCarthy, Phillips Petroleum Co., Bartlesville, Okla.; Cecil Phillips, Jr., Humble Oil & Refining Co., Baytown, Tex.; and C. H. Samans, Standard Oil Co. (Indiana), Whiting, Ind. Paper presented at midyear meeting, refining division, American Petroleum Institute, Philadelphia, May 13, under the original title, "Corrosion in Catalytic Reforming and Associated Processes."

REFINING

Magnitude of Panel Survey

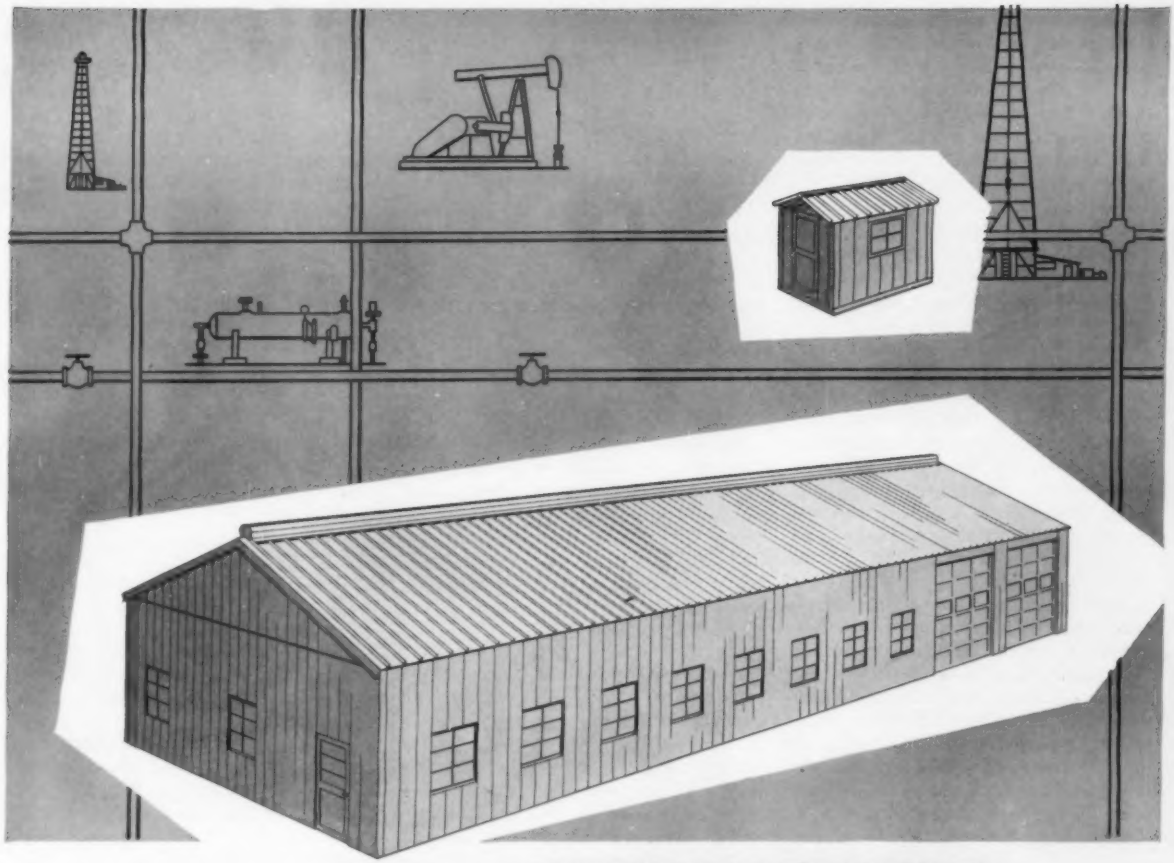
The panel contracted 34 licensing and/or operating companies. Replies were received from 31 companies, representing experience with all types of commercial catalytic reforming units and desulfurizers which utilize hydrogen. Only four companies had no experience to report because of the short on-stream time of their units. Most companies had operating experience with more than one unit and, in many cases, with different types of units.

For feed desulfurizers utilizing hydrogen, one company reported that it seemed to get lower corrosion rates from hydrogen-hydrogen sulfide mixtures than would be predicted by published information. Although the literature indicates the need for 18-8 chromium-nickel steels for their service, they have had satisfactory results with straight chromium stainless steels.

A second company reported a case in which corrosion was found to be much lower than the rates predicted in the literature. Bauxite desulfurization was employed, and no measurable metal loss was found after 5 months of operation with a naphtha containing sulfur equivalent to 0.120 per cent by volume of hydrogen sulfide.

Corrosion severity . . . For the purpose of the survey, corrosion was considered serious whenever it or its products interferred with the normal operation of the unit. Of the 27 companies reporting, 21 experienced serious corrosion in at least one of their units.

Of the six companies reporting no serious corrosion, one reported that early indications of very rapid corrosion in heater tubes to be the result of excessive tube-wall temperatures. Another company reported moderate



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corrosion during the initial run, confined mostly to heater tubes, where the scale was 1/64 to 1/32 in. thick. Two companies reported that pilot-plant operations resulted in high corrosion rates; the results, therefore, were used to select the proper alloys in the commercial units.

The remaining two companies had essentially no hydrogen sulfide in their units because the catalyst was not of the platinum type; the sulfur in the charge stock combined with the catalyst and was released as sulfur dioxide on regeneration.

Preventive measures . . . Seven companies reported that no preventive measures were incorporated against high-temperature hydrogen sulfide attack in their catalytic reforming units when first built. Generally, their experience with catalytic cracking and thermal reforming units was used to guide the selection of materials.

Low-chromium-molybdenum steels were used extensively for high-temperature service and to guard against hydrogen attack. Some 18-8 chromium-nickel steels were used for their high-strength properties. One company employed feed desulfurization unless the sulfur was low; at the higher-sulfur levels, parts of the unit were designed with added corrosion factors.

Of the 21 companies reporting serious corrosion in at least one of their units, 7 had employed some stainless-steel alloying, 5 used feed desulfurizers, 4 used hydrogen sulfide-removal systems on the recycle gas, and 2 used aluminizing. Several companies used combinations of these preventive measures.

The serious corrosion, however, did not occur in locations where suitable preventive measures were used. The type of serious corrosion was not always the same, it was not always sulfidic in nature, and experiences were not directly comparable for similar units.

Nature of corrosion . . . The following list shows the various types of difficulties encountered and the number of companies reporting each type:

	Number of Companies
1. Excessive metal loss (above that anticipated)	20
2. Heavy scaling of furnace tubes, exchangers, and/or transfer lines	18
3. Plugging of catalyst beds	16
4. Fouling of heater and exchanger tubes	13
5. Stress-corrosion cracking of austenitic stainless steel	7
6. Pitting or condensate-chloride corrosion	6
7. Hot spots in furnace tubes	3
8. High-temperature hydrogen attack on carbon-steel reactor internals (not on pressure-retaining components)	3
9. Carburization	1
10. Dezincification	1
11. Fatigue failure due to vibration	1

Metal Loss and Scaling

Data in the current literature on high-temperature hydrogen sulfide corrosion adequately illustrate the degree of metal loss and scaling which can be expected under various catalytic reforming conditions. In one case cited for the panel, 500 lb. of scale was removed from one fixed-bed reactor after 8 weeks of operation.

It was mentioned that the scale formed is too porous to be inhibitive as in thermal cracking where coke plugs the pores of the scale. The scale formed is chiefly from monosulfide. The use of X-ray fluorescent techniques shows that, initially, chromium tends to concentrate in the scale at the metal surface.

Not all scaling difficulties, however, are explained by the available information. One company reported extensive scaling on the feed side of 5 per cent chromium-molybdenum preheat exchanger tubes. This was very similar to iron sulfide scale found at high temperatures in a hydrogen sulfide-hydrogen atmosphere, except that no hydrogen was added to the feed stream.

A theory was advanced by the company that hydrogen from the reactor effluent stream inside the tube diffuses through the tube walls. However, the panel believes that it is more likely that the hydrogen present was either dissolved in the feed or produced by thermal cracking.

Plugging due to scale accumulation in the catalyst bed usually results in high pressure drop, sometimes necessitating lowering of the unit throughput. Plugging which resulted from flaking scale was the indirect cause of a damaging fire in one case.

Fouling . . . Fouling of exchanger tubes has been particularly troublesome in many installations. Fouling, similar to a case reported in the literature recently,[16] was prevalent in exchanger bundles before naphtha pretreaters, in the vapor phase or at the vapor point, and was usually due to sulfur and oxygen compounds.

The fouling may be accompanied by some corrosion, since in one case (< 0.06 per cent by weight of sulfur, at 400° to 500° F., with hydrogen present) several leaks were found on testing. However, this was after the fouled bundles were cleaned by acid washing, and the panel believes that this may have been the real cause of failure.

Fouling may occur on the fresh-feed or shell side of the exchangers where no hydrogen is present. This may be in the form of a relatively loose layer of scale, plus a carbon buildup on the outside of the tubes. Remedies that have been tried, but not always successfully, usually center around the elimination of oxygen in the storage system.

Examples include gas-blanket storage tanks, use of floating-roof tanks, direct "rundown" of charge to unit, and installation of deaerator towers. Other methods include use of inhibitors, spare bundles, duplicate exchangers and bypass connection, and replacement of carbon steel and low-chromium steels with 18-8 chromium-nickel steels.

Stainless-Steel Failures

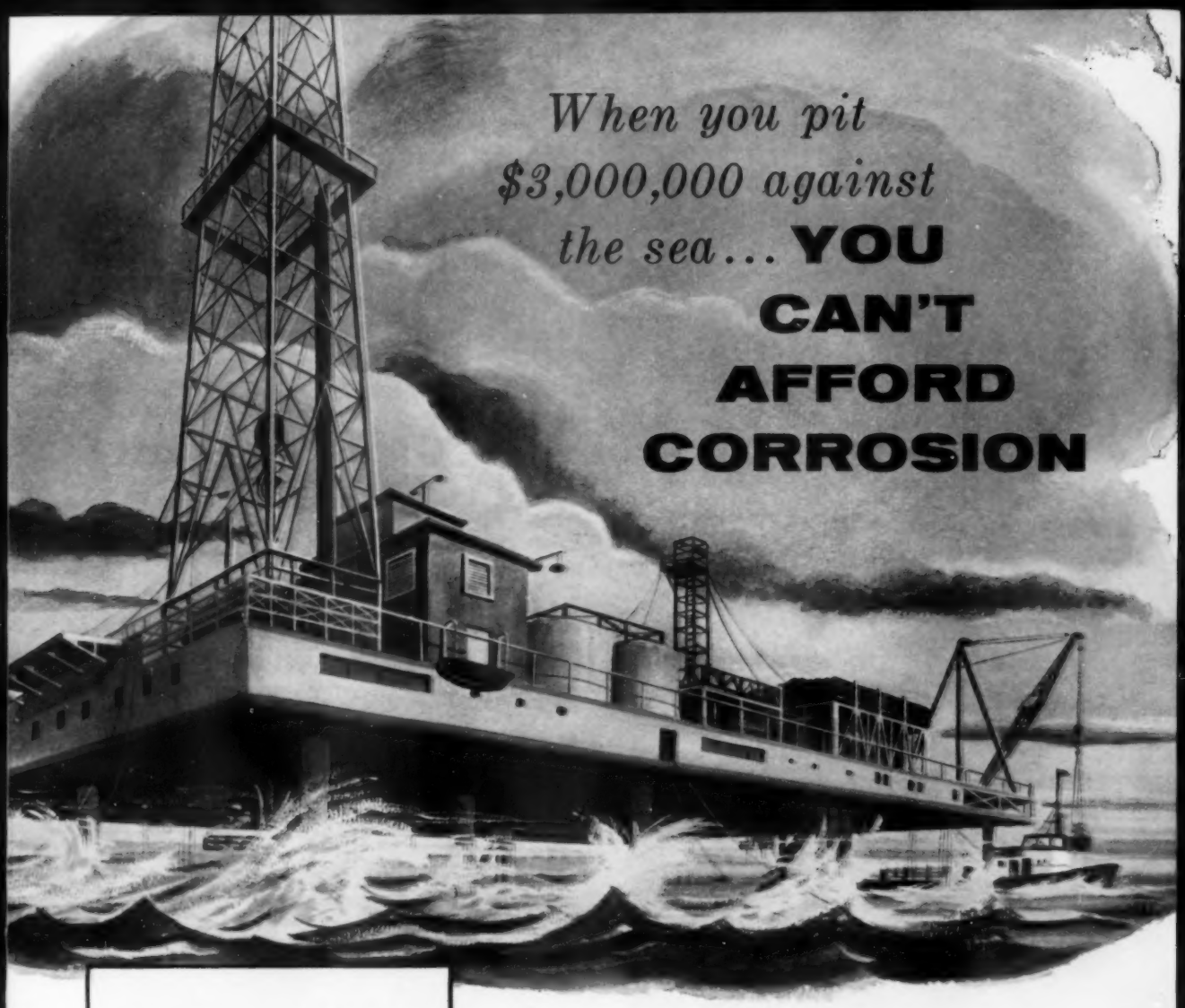
After 1½ years of operation, eight stainless-steel furnace tubes (Type 304, original thickness 0.31 in.) in one unit were retired because they were pitted below the minimum wall thickness. Two of these were coked solidly and were deeply pitted to a minimum wall thickness of 0.14 in. This pitting was not believed to be the result of sulfur corrosion.

The operating temperature was 1,120° to 1,175° F., but may have been abnormally high at times. The only microstructural defect observed was carburization of all inside surfaces, 0.002 to 0.010 in. deep, but the degree of carburization could not be correlated with the severity of pitting.

Cracking of austenitic welds in both ferritic and austenitic furnace tubes has been reported. Here the important factors were reported to be welding quality, inherent microfissuring of austenitic weld deposit, and possible stress-corrosion cracking from the formation of polythionic acids from iron sulfide scale and moisture during turnarounds.

To prevent this type of failure, increased efforts are made to insure sound welds by radiographic and dye-penetrant examination, hydrostatic test, and use of welding rods containing a small amount of ferrite. Also, before the furnace coils are opened for a down period, they are filled with a 5 per cent solution of sodium carbonate to neutralize any acids which may be formed.

Stress-corrosion cracking has been reported in Type 304 stainless steel in parts other than furnaces. Stress from bending and corrosion from hydrogen sulfide were reported to have caused a tube operated at 1,100° F. and 265 psig. to crack at a U-bend. Stress relieving (conditions not given)



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is now recommended. A Type 304 nozzle cracked in similar service and was replaced with 4 to 6 per cent chromium steel. The panel knows of no generally recognized case of stress-corrosion cracking at high temperature; the panel believes these failures were probably the result of corrosion during a shutdown.

Trouble in the nature of stress corrosion, hydrogen embrittlement, or corrosion fatigue has been experienced in relief valves and compressors handling hydrogen sulfide. This has been attributed by one company to the action of hydrogen sulfide upon metals subjected to frequent changes in tension or compression. The failures were very rapid—in a matter of hours in some cases—with all types of ferrous material, including stainless steel.

The company claims that this difficulty can be overcome by the use of Inconel, "K" Monel, or aluminized carbon steel, preferred in that order.

Intergranular attack . . . A Type 304 stainless-steel thermowell in a furnace outlet line was found badly corroded under the following operating conditions, which included one 5-minute period of steam-air decoking; temperature, 1,180° to 1,200° F.; hydrogen content, 60 per cent. Examination showed intergranular attack, probably from sulfur compounds, with subsequent spalling; the hottest part was carburized and pitted.

In Hydrofiner service, some intergranular attack of Type 304 stainless steel has occurred and has caused pipework failures. The source of this information believes Type 304 to be susceptible to intergranular attack by hydrogen sulfide above 650° F. No intergranular attack by hydrogen sulfide has been reported on 18-8 materials stabilized by columbium or titanium.

An unpublished German report states that these stabilized 18-8 materials form a protective film of iron sulfide scale which is very adherent and should not be removed during shutdown periods. Intergranular cracking adjacent to welds in Type 304 tubing in catalytic reforming service has also been reported in the literature.[17]

Chloride corrosion . . . Reports have been received that corrosion in shell and outlet piping of final reactor effluent coolers is believed to be attributable to hydrochloric acid produced from alternate injection of chloride and water into reactors to maintain catalyst activity. Chloride corrosion, aggravated by temperature variation and turbulence, also caused failures at the junction of liquid lines from hot and cold receivers.

This was eliminated by rearrangement of piping for better flow conditions, plus alloy lining of the junction areas (the type of alloy was not given).

Several reports state that exchanger tubes, particularly after feed pretreaters, have been plugged, as much as 80 per cent, with ammonium chloride. In another instance it was believed that stress-corrosion cracking of antimonial admiralty exchanger tubes and compressor valves was promoted by ammonium chloride. Where this trouble developed, the stripper, rerun towers, and condensers are now water-washed until all blue color (indicative of copper compounds) is gone whenever they shut down.

Hot-spot failures . . . One hot-spot rupture resulted in an explosion and fire damage. Typical hot-spot splits, mostly on "roof" and outlet tubes, have been cited. In some cases faulty thermocouple installations may have permitted excessive metal temperatures.

In one unit this type of failure on 5 per cent chromium heater tubes was reported to be due to a thick (¼ in.) layer of scale, sometimes with ⅛ in. of carbon over the scale. Acid clean-

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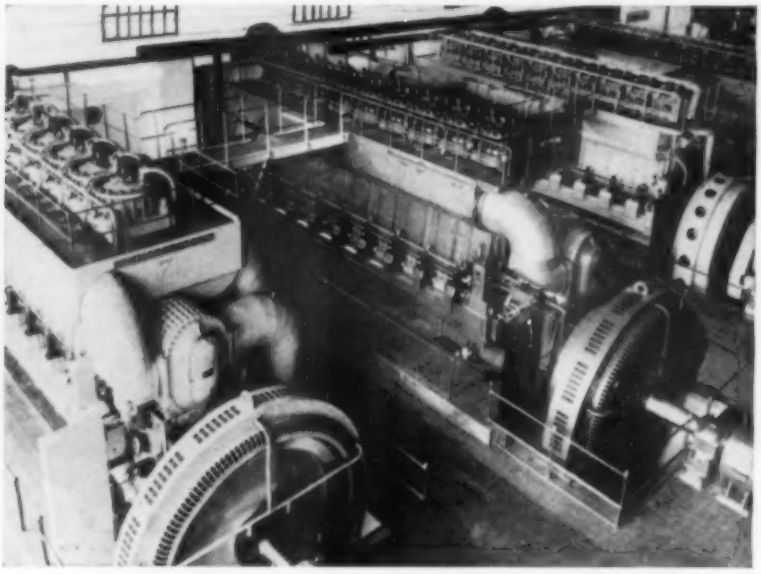

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ing alone did not eliminate these deposits. Now steam-air decoking is used prior to acid cleaning.

Moisture . . . For one type of design, after a year of operation, two of six desulfurization units had serious scaling trouble. The total sulfur in the charge to all these units was below 0.1 per cent by weight; all contained chloride ion. Scaling was worst when the naphtha was saturated with water and least when the naphtha was dry.

In the four units where no serious trouble occurred, the charge stocks contained 150 to 180 p.p.m. of water, but no free water. (The charge to the reformer reactor section is considered dry at 20 p.p.m. of water).

Important factors . . . There was unanimous agreement that the most important factors in catalytic reformer corrosion were the concentration of hydrogen sulfide in a hydrogen atmosphere and temperature. Three companies were of the opinion that when hydrogen chloride was present, it contributed to the severity of the corrosion.

Oxygen content of the feed and the alternating from reducing to oxidizing (during regeneration) conditions were considered important factors by three companies. The following secondary factors were mentioned: pressure; geometry of the corroding surface; ammonium chloride; and sulfur, nitrogen, water, and arsenic content of the feed.

Corrosion measurements . . . In commercial units practically all companies measure corrosion by use of audigage, penetron, calipers, and pipe-gage surveys. In addition, 17 companies use test specimens or metal coupons in either commercial, pilot-plant, or laboratory units to obtain corrosion rate measurements. Some companies are also using corrosion probes in these units. [12 13]

Analytical measurements . . . Sulfur in naphtha streams is generally obtained by the lamp method. A.S.T.M. method D90-55T specifies purified air for the combustion gas, followed by a gravimetric finish. If titration procedures are used as a finishing step, this method results in high values, particularly when determining low concentrations of total sulfur. A titration finish can be used with A.S.T.M. method D1266-55T, which specifies the use of a carbon dioxide-oxygen mixture as the combustion gas.

The Tutwiler method for determining hydrogen sulfide in gas streams is the most popular, although mass spectrometry, M.S.A. gas testers, and gas absorption in sodium hydroxide followed by potentiometric titration have been used also.

No details were specified for determining trace amounts of the other possible corrodents mentioned.

Control of Corrosion

The following list shows the methods being used to combat and/or control corrosion, and related difficulties, in catalytic reformers and associated equipment and the number of companies reporting their use.

	Number of Companies
1. Proper alloying, generally with 18-8 chromium-nickel at high temperature	13
2. Feed-stock desulfurization	11
3. Hydrogen sulfide removal in recycle gas	8
4. Aluminizing	8
5. Acid cleaning (to remove scale)	5
6. Radial flow reactors or mechanical scale catchers	4
7. Alloy linings	3
8. Periodic screening of scale from catalyst	3
9. Reduction of temperature where possible	2
10. Decoking (to facilitate later acid cleaning)	1
11. Use of guard case for desulfurizing, olefin hydrogenation, and arsenic removal	1
12. Use of amine-type inhibitors	1

Other companies are known to use some of the foregoing methods, but

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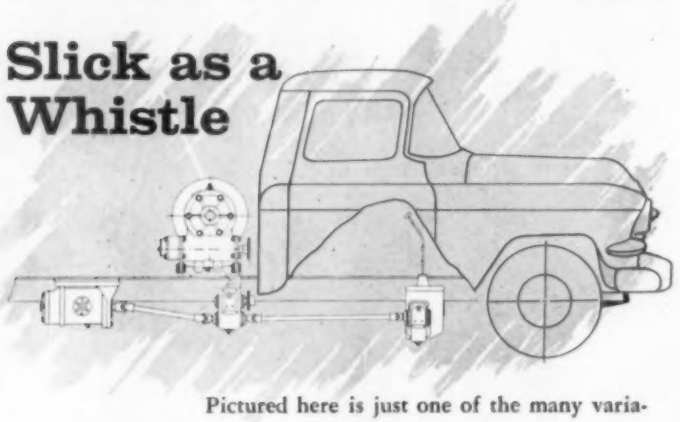

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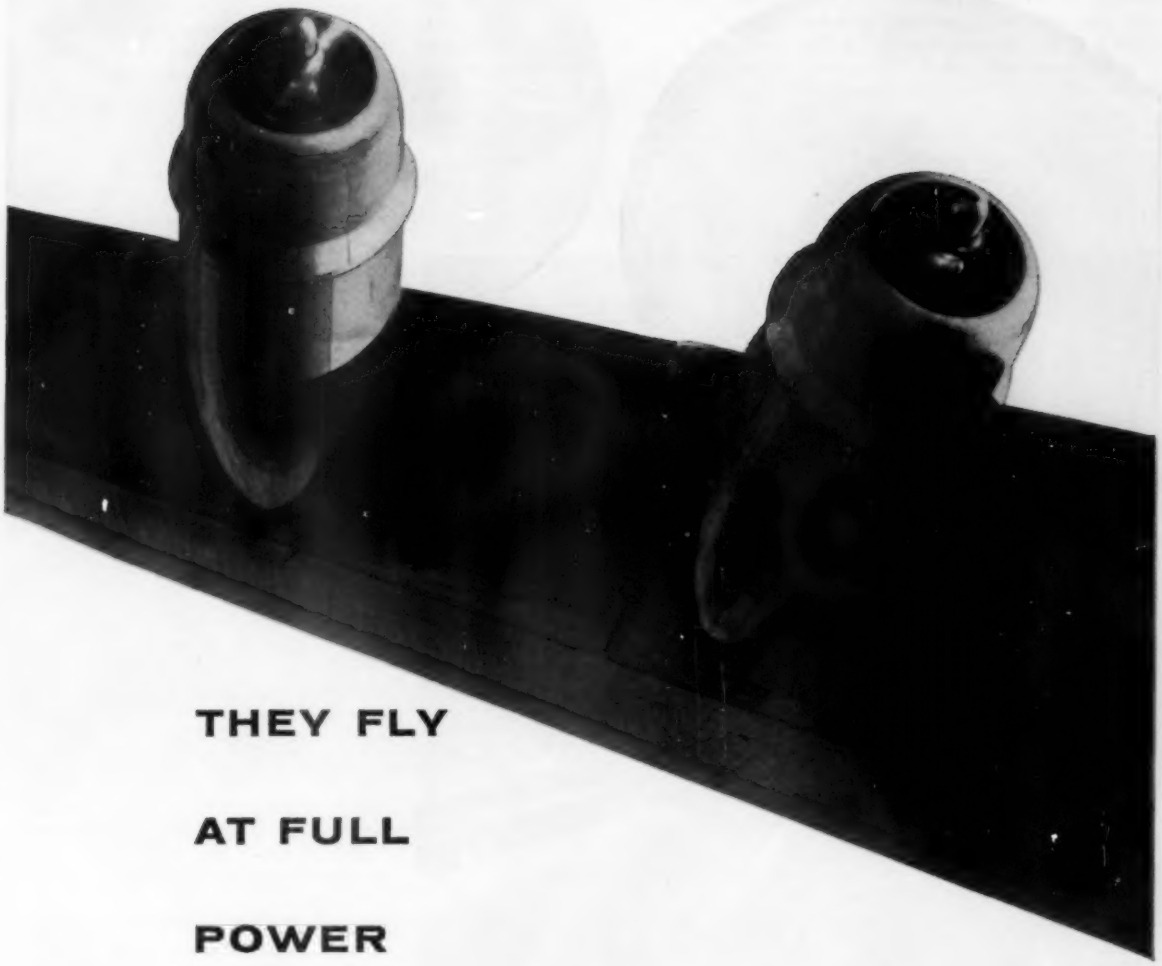

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they did not list them as important ways to control corrosion.

There appears to be a general opinion that the combination of sulfur in the charge (calculated as hydrogen sulfide) and that in the recycle gas should be below 0.006 to 0.01 per cent by volume to minimize corrosion in low and intermediate alloy-steel furnace tubes and hot transfer lines.

Some companies reported, however, that 0.015 to 0.02 per cent by volume of hydrogen sulfide did not result in serious corrosion. There have been indications that the type of sulfur in the charge to desulfurizers might have an effect on corrosion.

Removing scale . . . The difficulty of removing scale from corroded metal was mentioned by several people. Even though apparently adherent, such scale offers little protection against further corrosion and tends to flake when the unit goes back on stream. Sandblasting of scale from reactor vapor outlet screens and hydroblasting of exchanger bundles are commonly used. The acid cleaning generally employed appears to be the inhibited-hydrochloric acid type, with good success reported. Oxalic acid cleaning may only loosen scale and do very little dissolving.

Steel, coated with aluminum by calorizing, hot dipping, or spraying, has been shown to be very effective experimentally, but is not always considered a satisfactory means from a practical standpoint in view of the tendency to flake and the difficulty of welding. Nonetheless, considerable aluminized steel is now being used and tested in commercial units.

When resistance to sulfide corrosion is necessary, the trend is toward more extensive use of 18-8 chromium-nickel steels, particularly in desulfurizing equipment. Because of this, a review of some experiences with Autofiners may be in order. Autofiners utilize 18-8 material in considerable quantity.

Typical recycle gas will contain 5 per cent by volume of hydrogen sulfide, 85 per cent by volume of hydrogen, and 10 per cent by volume of hydrocarbons, usually in the gas-oil boiling range. The heater and transfer-line temperatures are as high as 780° F. at pressures of 100 to 225 psig. The reactor catalyst is regenerated *in situ* at approximately 850 to 1,100° F. with steam-air mixtures.

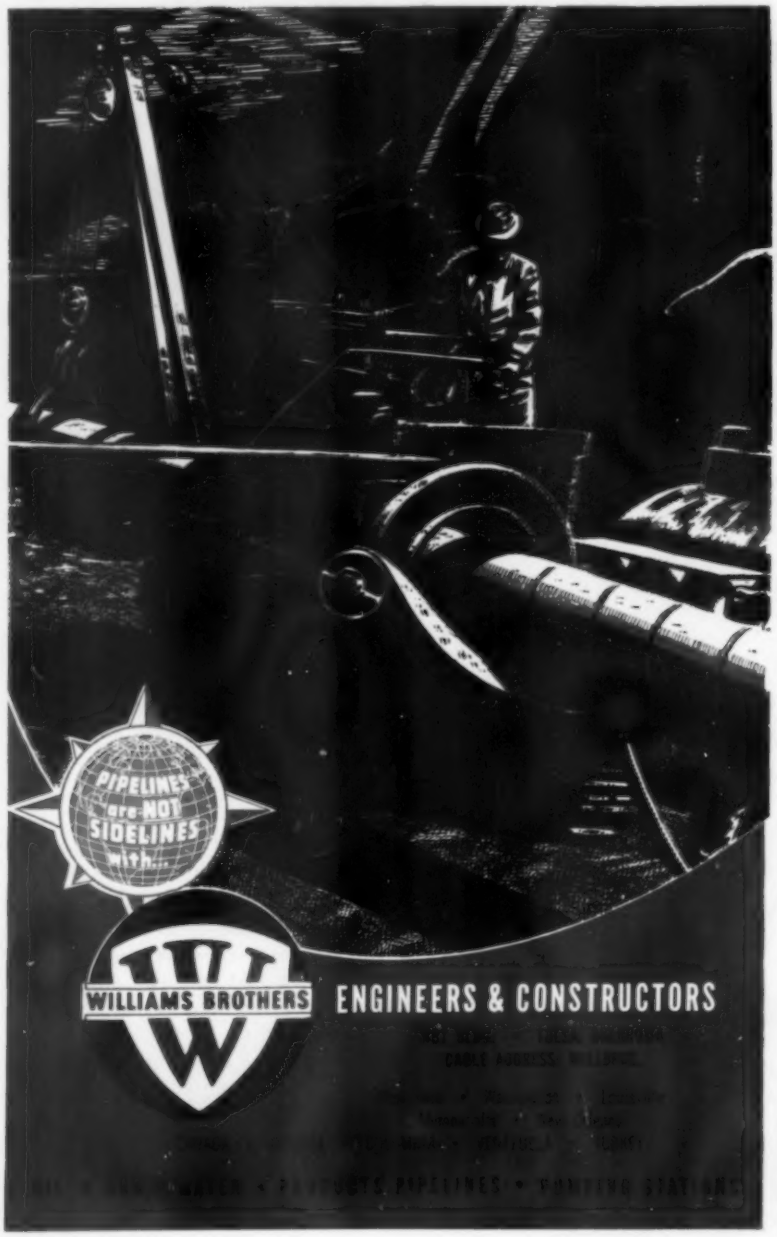
In one Autofiner the transfer lines were fabricated from 4, 6, and 8-in.-diameter pipe. The 4-in. pipe was drawn tube, and the 6 and 8-in. pipes were formed from rolled plate by shaping and longitudinal seam welding. All the pipe material was titanium-stabilized 18-8 chromium-nickel and the electrodes were columbium-stabilized 18-8. The weld joints were not heat-treated or inspected by X-ray after welding.

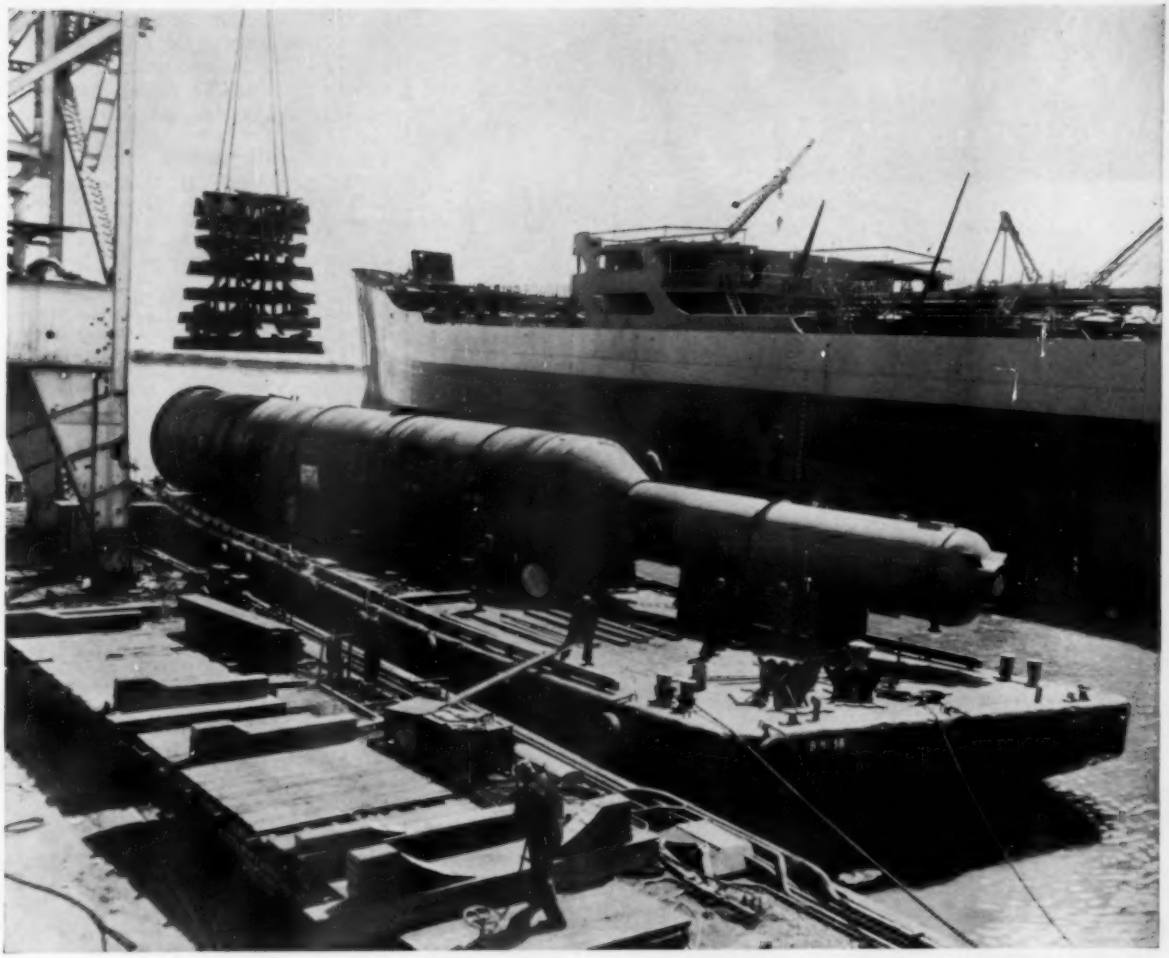
Apart from one crack in a flange-to-pipe seal weld, attributed to poor welding technique, no corrosion or cracking troubles occurred on the 18-8 stainless steel after 4 years of operation. It has been concluded from a thorough examination (visual, liquid penetrant, and X-ray) that the welded joints and parent metal of the stainless-steel transfer lines are sound and have not suffered any deterioration during the 4 years of Autofining operation which included 35 regenerations.

The pipework was considered suitable, in its present condition, for a further indefinite period of service.

For Autofiners, postweld heat treatment on columbium and titanium-stabilized 18-8 was not believed to be justified if solution heat treatment was applied prior to fabrication.

With the heating of feed stock, corrosion results chiefly from the breakdown of sulfur bodies. The sulfur compounds in straight-run gas oil are





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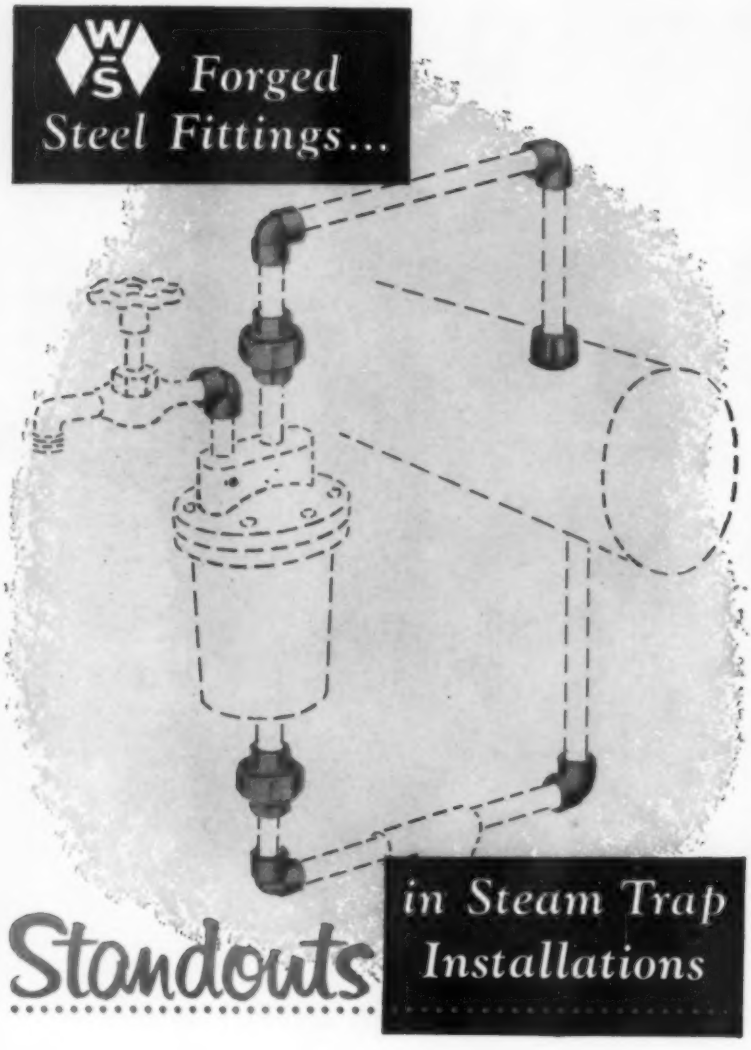

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less stable than those in cracked cycle oils, so that although the actual sulfur content of the cracked stocks may be higher, the corrosive action may be less than with straight-run gas oils.

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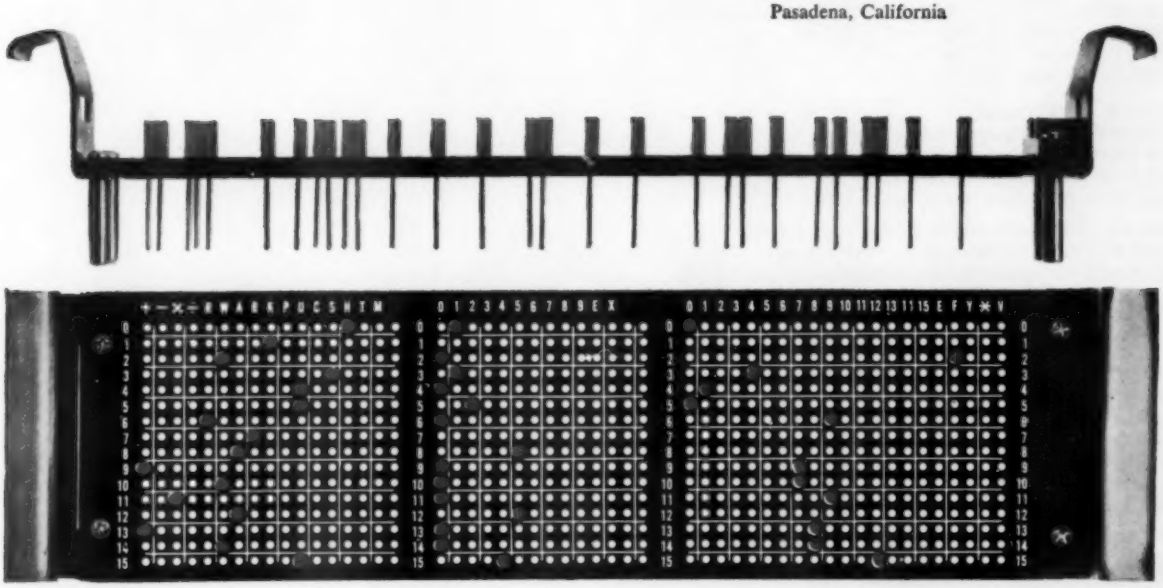

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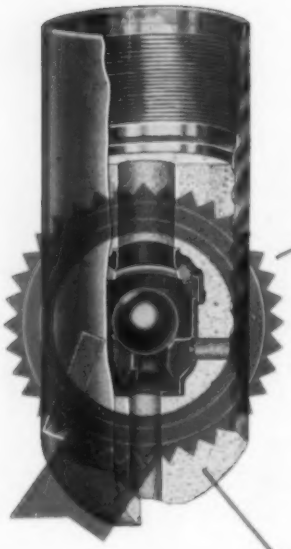

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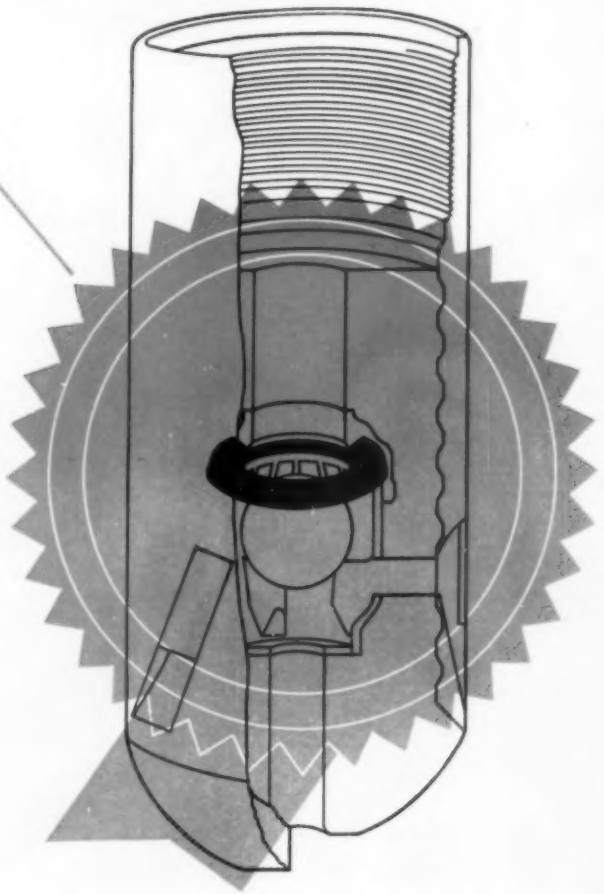

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How Rotary Speed and Bit Weight Affect

ROTARY DRILLING RATE

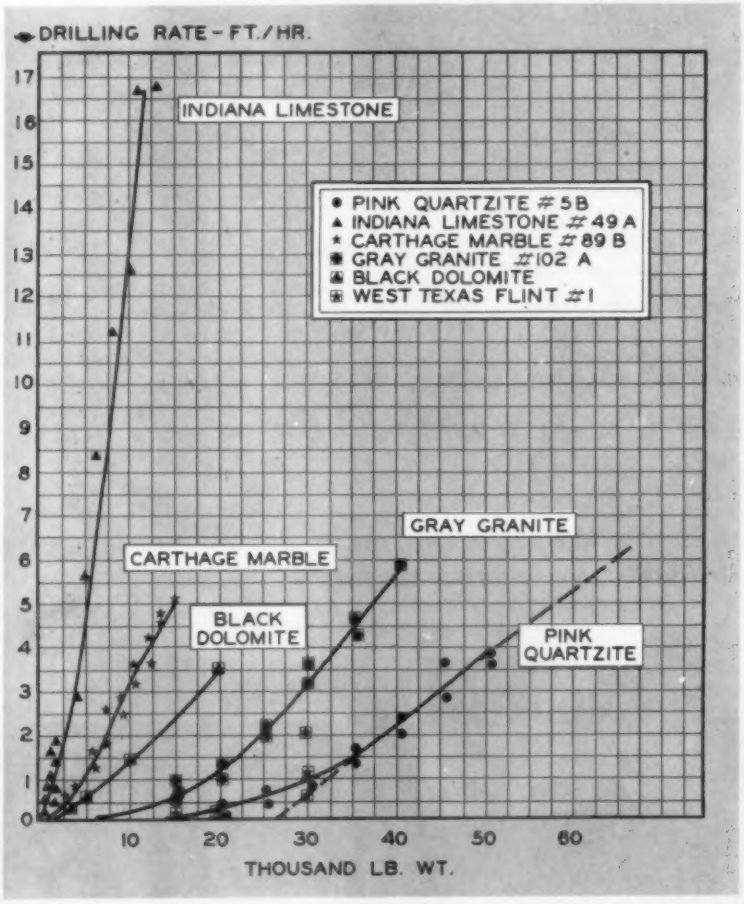
Even with practical field limits, a better combination of these factors may reduce your drilling costs

by Carl Gatlin

VARIABLES affecting rotary-drilling penetration rate are exceedingly numerous. Some of the more recognizable are the effects of drilling-fluid properties, hydrostatic pressure, hydraulic factors, rotary speed, and weight on bit. This is to say nothing of personnel and rig efficiency, straight-hole requirements, and the extreme variance of rock properties and other subsurface conditions in different areas.

Consequently it is doubtful that any general solution to the drilling problem exists. However, the separate effect of many of the above variables may be studied provided, of course, all the others are held reasonably constant.

In hard-rock areas penetration rate is limited by the weight on bit or rotary speed which may be applied or both. Normally these limits are imposed by either crooked-hole or equipment considerations. This discussion will deal with the individual and combined effect of these two factors as indicated from various data in the literature. Other variables will be assumed constant or of no consequence except where noted.



EFFECT OF BIT WEIGHT on rate of penetration for various rock types. (Courtesy Hughes Tool Co.) Fig. 1.

Weight on Bit

The general effect of bit weight on rate of penetration is shown in Fig. 1.[1] These data were obtained from laboratory tests on numerous rock specimens exhibiting compressive strengths as shown in Fig. 2.[1] Note that there are two distinct regions on the drilling rate curves, i.e.:

1. Drilling at bit weights below the compressive strength of the rock (out to approximately 30,000 lb. for the pink quartzite).

2. Drilling at bit weights sufficient to overcome the compressive strength of the rock.

Obviously, operational bit weights in region (2) are desirable and are applied if possible. Note that the points above the critical load (bit weight necessary to exceed rock's compressive strength) are reasonably well approximated by a straight line, or:

$$R_p = a + b\,W \qquad (1)$$

where:

R_p = penetration rate, ft./hr.
W = weight on bit, lb.
a, b = constants dependent on rock properties, and bit size and type.

Other data, both field[2 3 4] and laboratory,[5 6] tend to substantiate the linearity of R_p versus W over reasonable ranges of bit loading.

As mentioned previously the above empirical observation implies complete constancy of all other factors. Among these is adequate cleaning and cutting removal—which does not necessarily mean constant circulation volume or nozzle velocity. The in-

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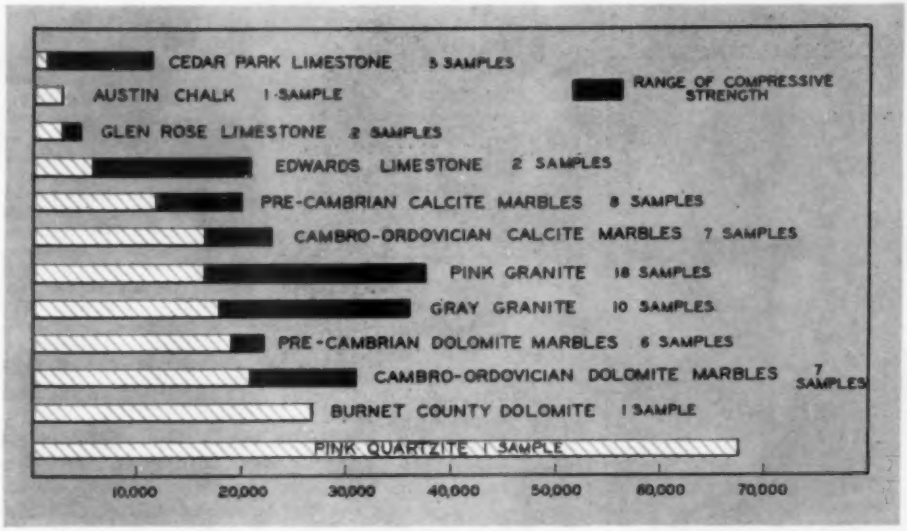


COMPRESSIVE STRENGTH of various rocks. Black indicates range of compressive strength within which operational bit weights above critical loads may not be desirable. Fig. 2.

crease in R_p due to an increase in W implies:

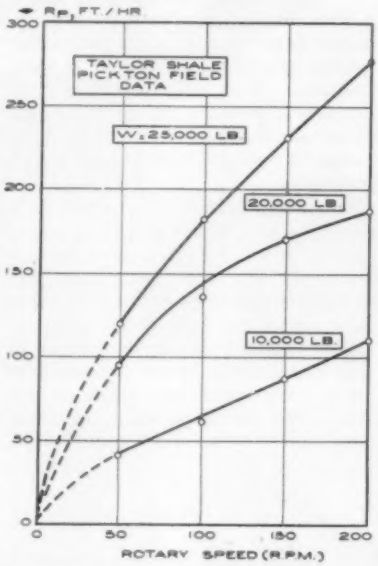
1. Greater tooth penetration (greater possibility of balling, etc.).
2. More (and probably larger) cuttings to be removed per unit of time.

Consequently, experimental results of penetration rate versus bit-loading studies may be affected by circulation inadequacies unless the flow rate is high enough to perform its function equally well at all test conditions.

Rotational Speed

The effect of this variable on penetration rate is hard to define, and incomplete agreement appears to exist on the entire subject. In general, rate of penetration increases with increased rotary speed. Exceptions to this have been pointed out wherein penetration rates decreased at rotary speeds above some optimum value.[2,4]

Whether or not such behavior was actually due to this factor alone or to some other unrecognized variable(s) is debatable. This is, of course, one of the main problems in the interpretation of field and even laboratory data.



EFFECT OF ROTARY SPEED on penetration rate at various bit weights. Replotted from data of Bielstein and Cannon.[3] Fig. 4.

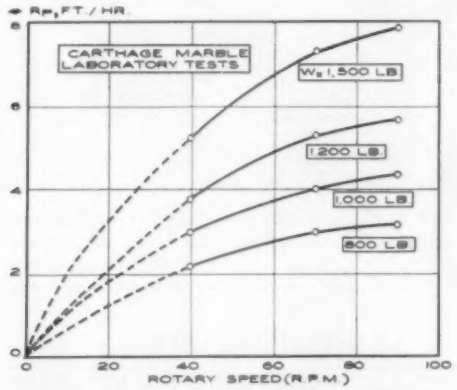
Figs. 3 and 4 show a relationship between drilling rate and rotating speed for some laboratory and field conditions. The dashed extrapolations are based on the premise that the curves must pass through the origin. These curves represent "on bottom" rates only and do not reflect the possibility of accelerated bit or drill-string wear.

As was mentioned previously, inadequate circulation rates can conceivably mask the effect of the variable under study. A satisfactory nozzle velocity for 100 r.p.m. is not necessarily adequate at 200 r.p.m. since at the latter speed a cutting will have only half as much time to clear bottom prior to the next tooth impact.

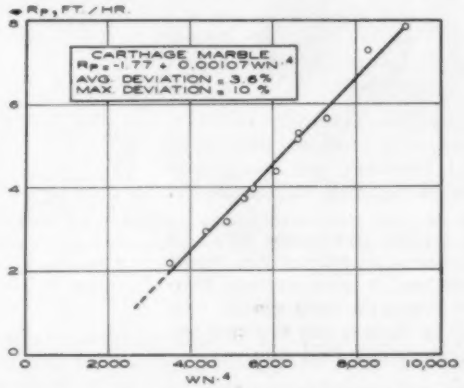
It is possible that studies of rotary-speed effects conducted at constant-circulation conditions do not measure the isolated effect of this variable. Just what the actual relationship among hydraulic requirements, bit weight, and table speed is for a given instance is unknown.

Weight and Speed

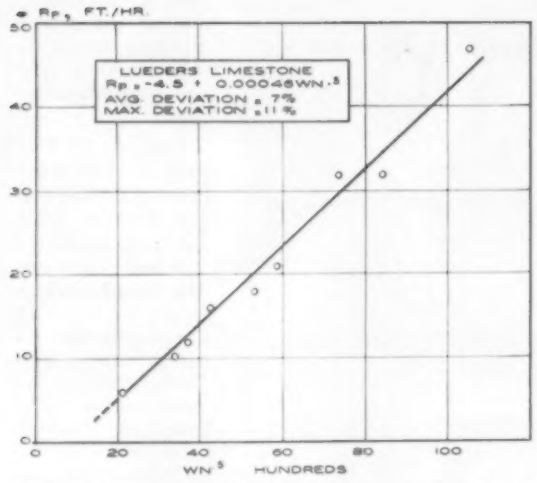
The combined effect of bit load and table speed on penetration rate is even more difficult to define than the independent effect of each variable. Murray and Cunningham[8] have used an empirical formula containing both variables which was attributed to H. B. Woods. Most data relating the three



EFFECT OF ROTARY SPEED on penetration rate at various bit weights. Replotted from data of Wardroup and Cannon.[6] Fig. 3.



RATE OF PENETRATION vs. $WN^{0.5}$ from laboratory data of Wardroup and Cannon.[6] Fig. 5.



RATE OF PENETRATION vs. $WN^{0.5}$ from laboratory data of Eckel.[5] Fig. 6.

variables, however, have been presented in the manner of Figs. 3 and 4 with little or no attempt to correlate the combined effect as a single parameter.

There is considerable theoretical basis for expecting penetration rate to correlate with the product, WN. Examination of limited published data fails, however, to bear out this premise.

The table speed, N, does not exert sufficient influence to be applied to the first power. However, if a fractional power of N, such as the square root, is used, a reasonable correlation is obtained. Figs. 5, 6, and 7 illustrate this procedure.

Note that the Wardroup and Cannon[6] data on Carthage Marble is correlated with $W(N)^{0.4}$ while Eckel,[5] and Bielstein and Cannon[3] data correlate better with $W(N)^{0.5}$. Consequently, for these data penetration rate may be expressed as:

$$R_p = c + d\,W\,(N)^e \qquad (2)$$

where:

c, d, e = constants dependent on rock type, and bit size and design (assuming drilling fluid and hydraulic effects constant).

These correlations apply in the region where bit loads are sufficiently high to overcome the compressive strength of the rock, i.e.: region (2) of Fig. 2.

Any specific conclusions based on such a limited quantity of data would be hazardous. It is of interest, however, to obtain the same general relationship for three widely scattered sets of laboratory and field data.

Limitations on W and N

These factors must, of course, be held within the operational limits imposed by economic drill string and bit life. The possibility of decreased overall penetration rate due to accelerated bit and drill-string wear, despite increased "on bottom" rate, must be considered as a practical limit.

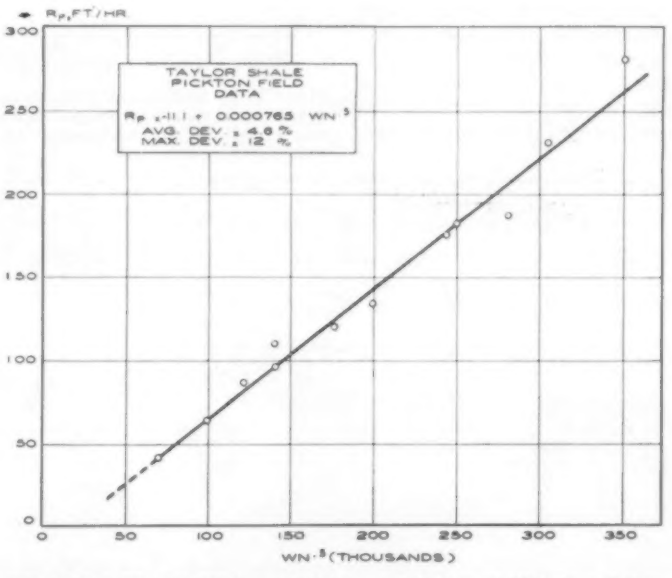
The limitation on bit weight is primarily governed by the allowable tooth stress of the bit itself. Rotational speed also affects bit performance, primarily through bearing wear, and the severity of vibrational loads. Crooked-hole considerations are ignored here although these may completely govern bit weight in a given instance. The current maximum bit loading is probably the 10,000-lb. per inch of diameter being applied to some bit types in the Permian basin.[6,7]

Drill-string failure . . . Most drill-string failures are attributed to material fatigue which has been aggravated by corrosion and/or improper care and handling.[9,10] Since fatigue failures are related to both the number of stress reversals and the magnitude of the stress, it should be expected that both table speed and weight on bit will affect the frequency of such failures. Of the two, table speed seems to be the more critical provided excessive hole-collar clearance is avoided. The drill collars and the adjacent sections of drill pipe receive the worst punishment from vibrational loads; and it is in these sections that most failures occur.

Theoretically, every drill string has a natural frequency at which vibrational effects are maximum. It is generally agreed that table speeds in resonance with this will result in severe vibrations and accelerated failure frequency.

Main[11] has presented mathematical formulas for computing this critical speed range based on certain simplifying assumptions. This method has not been widely applied.

Drilling practices . . . Crane[12] has suggested a drilling practice based on a constant weight-times-speed factor. This is a qualitative agreement with field practices in that as weight is increased, speed is decreased. The ques-



RATE OF PENETRATION vs. $WN^{0.5}$ from field data of Bielstein and Cannon.[3] Fig. 7.

THE AUTHOR

Carl Gatlin is assistant professor of petroleum engineering at Tulsa University. He holds a B.E. degree in petroleum engineering from University of Southern California and a M.S. degree in petroleum engineering from Tulsa University. He worked for Phillips Petroleum Co., Anderson-Prichard Oil Corp., and Texas Crude Oil Co. in various engineering capacities before starting to teach at Tulsa University in 1953.

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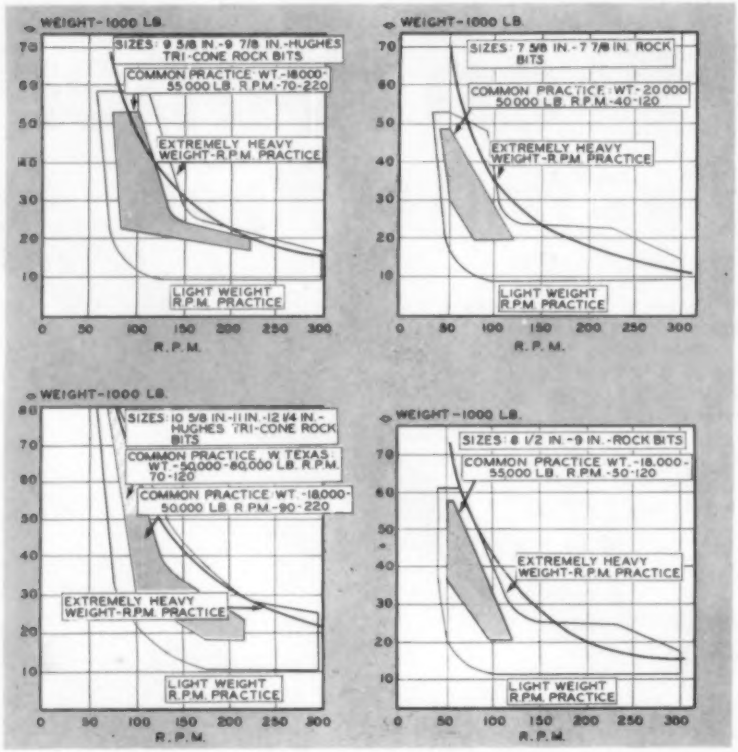
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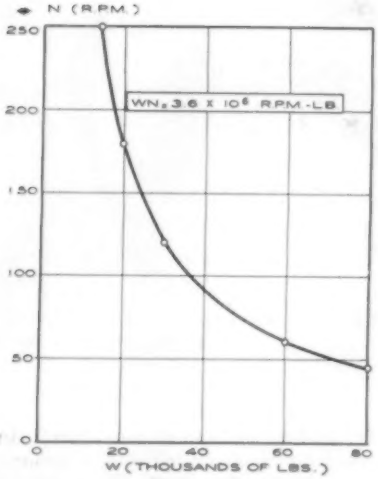
R.P.M.
WEIGHT-1000 LB.
SIZES: 7 5/8 IN.-7 7/8 IN. ROCK BITS
COMMON PRACTICE: WT.-20,000-50,000 LB. R.P.M.-40-120
EXTREMELY HEAVY WEIGHT-R.P.M. PRACTICE
LIGHT WEIGHT R.P.M. PRACTICE
R.P.M.
WEIGHT-1000 LB.
SIZES: 10 5/8 IN.-11 IN.-12 1/4 IN.-HUGHES TRI-CONE ROCK BITS
COMMON PRACTICE, W. TEXAS: WT.-50,000-80,000 LB. R.P.M. 70-120
COMMON PRACTICE: WT.-18,000-50,000 LB. R.P.M.-90-220
EXTREMELY HEAVY WEIGHT-R.P.M. PRACTICE
LIGHT WEIGHT R.P.M. PRACTICE
R.P.M.
WEIGHT-1000 LB.
SIZES: 8 1/2 IN.-9 IN.-ROCK BITS
COMMON PRACTICE: WT.-18,000-55,000 LB. R.P.M.-50-120
EXTREMELY HEAVY WEIGHT-R.P.M. PRACTICE
LIGHT WEIGHT R.P.M. PRACTICE
R.P.M.

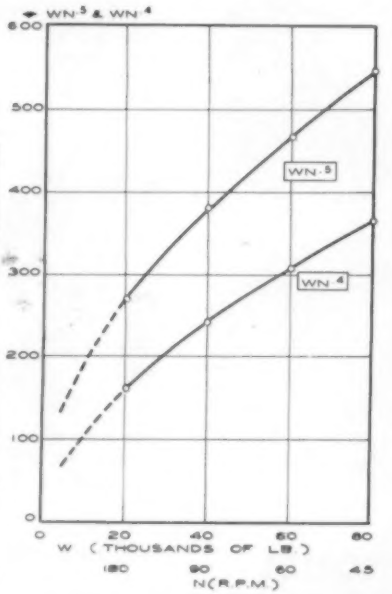
Fig. 8.

DRILLING PRACTICE curves showing applied range of weight-speed combinations for various bit sizes. (Courtesy Hughes Tool Co.) Curves of constant weight × speed product have been added as follows:

Bit Size (in.)	W × N
7⅝ to 7⅞	3.6×10^6 r.p.m.-lb.
8½ to 8	4.0×10^6 r.p.m.-lb.
9⅝ to 9⅞	4.8×10^6 r.p.m.-lb.
10⅝ to 12¼	6.4×10^6 r.p.m.-lb.



LIMITING WN for 7⅝ to 7⅞-in. bits as estimated from Fig. 8, and corresponding W - N combinations. Fig. 9.



BEHAVIOR of $WN^{0.4}$ and $WN^{0.5}$ for WN = 3.6×10^6 r.p.m.-lb. R_p will parallel above curves for those cases which fit this analysis. Fig. 10.

tion which arises is the limiting value which should be applied, i.e. WN = ?.

A satisfactory solution in one area would not necessarily apply to another where conditions, particularly corrosion, are different. It is, however, possible to estimate this factor based on what are considered as standard operating practices.

For example, Fig. 8 shows common operating weight - speed ranges for various bit sizes. Constant WN curves added to these approximate the operating trend with a reasonable degree of accuracy.

The WN values shown were chosen arbitrarily in an attempt to approximate the indicated maxima. If it is assumed that these data represent the current limiting conditions, then a constant WN factor is a reasonable solution to allowable table speed-bit weight combinations.

Highest drilling rate . . . Fig. 9 is a replot of the WN factor for 7⅝ and 7⅞-in. bits. Fig. 10 shows the behavior of $W(N)^{0.5}$ and $W(N)^{0.4}$ for the same limiting WN product.

Behavior of penetration rate, R_p, will parallel the change of $W(N)^e$, according to Equation 2, for cases where this analysis fits (Figs. 5, 6, and 7). Penetration rate is therefore highest for high bit weights and low rotary speeds where weight times speed is kept constant.

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QUANTITATIVE LOG ANALYSIS—7

by Dr. R. G. Hamilton
and Paul Charrin

How to Find Porosity From Normal Curve And Neutron Log

DETERMINING porosity and formation factor from the invaded 16-in. normal curve has given exceptionally accurate average values of Φ in areas where formations are fairly deeply invaded and are not shaly. The method should be used only when the formations are invaded and in general when R_i/R_m is 20 or greater. The method is most accurate when the rock porosity is 15 per cent or less.

If applied to shaly formations, the method will overestimate porosity. It should never be employed for noninvaded or only slightly invaded formations. These limitations restrict its use generally to the hard-rock areas.

Porosity is obtained from the relationship:

$$\Phi = C\,[1/(R_i/R_m)]^{1/m}$$

C is a constant related to the mixture of fluids in the invaded zone and is determined from the S.P. curve.[8]

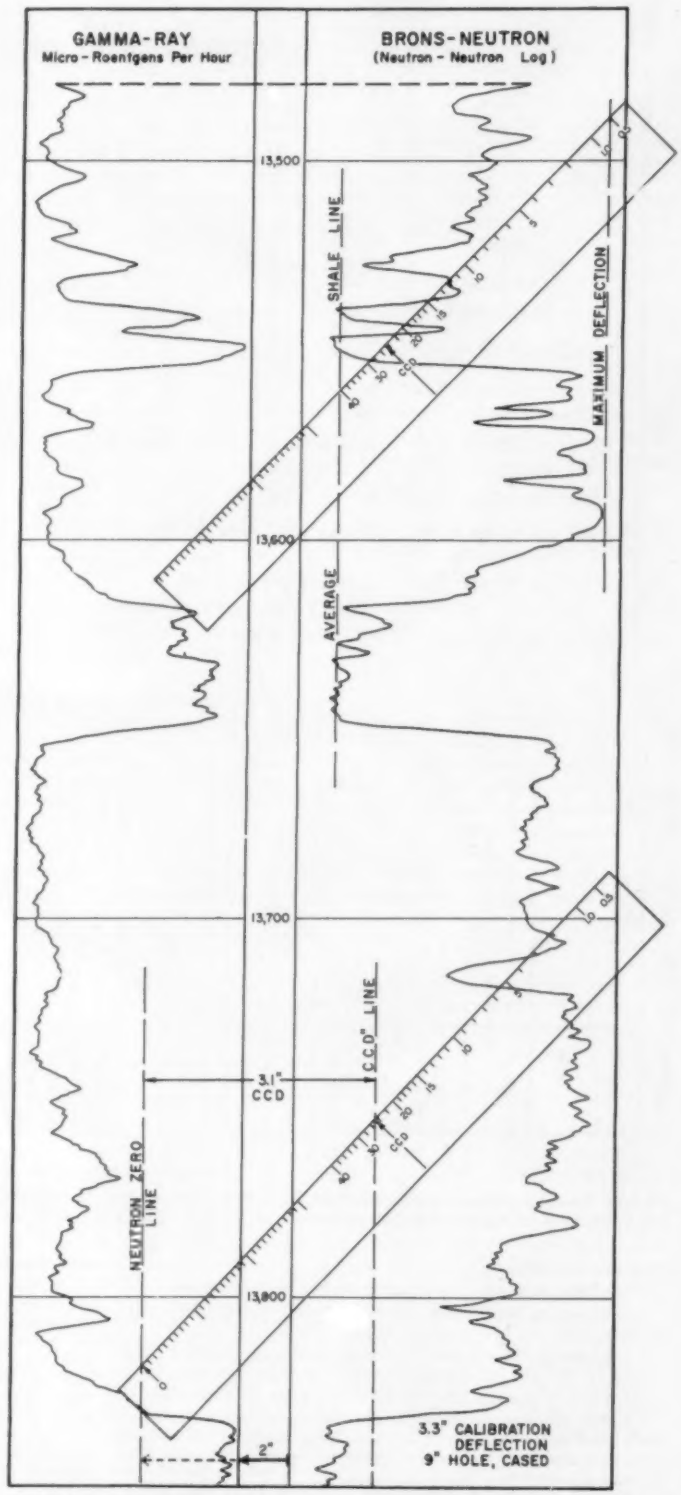
The value $R_{16''}/R_m$ is corrected to R_i/R_m by Charts 6 or 7 (Part 4). SSP is obtained from a thick bed or calculated from Charts 4 and 5 (Part 3).

Chart 13 solves the equation. Instead of employing numbers for the C values, the corresponding SSP value is used. Follow instructions on Chart 13.

Neutron-Neutron Log

In nonshaly formations porosity estimates can be obtained from the neutron-neutron log. The "neutron zero" method may be employed for P.G.A.C. logs recorded subsequent to September 1953 in holes containing fluid. The "shale line" method may be applied to any log, including those recorded in empty holes. The accompanying figure shows the use of a transparent rule with the two methods.

Authors are, respectively, head of Hamilton Well Log Consultants, Tulsa, and president of Perforating Guns Atlas Corp., Houston.



TWO METHODS FOR POROSITY from the neutron log are the shale-line method at top and the neutron-zero method at bottom. Scales may be made from Chart 14. Below Chart 14 is explanation of methods.

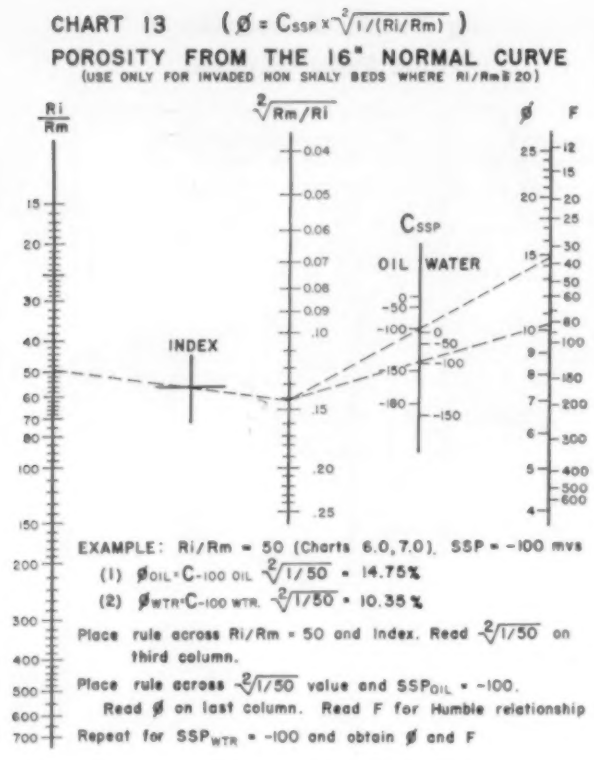


CHART 13 (Ø = Cssp x ²√1/(Ri/Rm))
POROSITY FROM THE 16" NORMAL CURVE
(USE ONLY FOR INVADED NON SHALY BEDS WHERE RI/RM≥ 20)
Ri/Rm
²√Rm/Ri
Ø
F
Cssp
OIL
WATER
INDEX
EXAMPLE: Ri/Rm = 50 (Charts 6.0,7.0), SSP = -100 mvs
(1) ØOIL=C-100 OIL ²√1/50 = 14.75%
(2) ØWTR=C-100 WTR. ²√1/50 = 10.35%
Place rule across Ri/Rm = 50 and Index. Read ²√1/50 on third column.
Place rule across ²√1/50 value and SSPOIL = -100. Read Ø on last column. Read F for Humble relationship
Repeat for SSPWTR = -100 and obtain Ø and F

Calibration Procedure

The Brons-neutron counter does not respond to gamma rays of any energy level. It is possible to calibrate this instrument on the surface against hydrogen, which it measures principally while logging in the bore hole.

The instrument is placed in horizontal position 4 ft. above the ground. Operating power is applied as in bore-hole operation. Since there is no hydrogen in proximity to the instrument, the pen in the recorder assumes position of an absolute "neutron zero."

The calibrator device is then fixed on the instrument (a fixed position that includes the radium-beryllium source and neutron detector). Due to the hydrogen in the calibrator, the detector responds and the pen travels to the right. The amount of pen travel from zero will be referred to as the calibration deflection.

Pen travel can be controlled by the logging operator. The selection of a calibration deflection depends upon (a) bore-hole diameter, (b) fluid in bore hole or casing or same being dry, and (c) lithology of series included in interval to be logged.

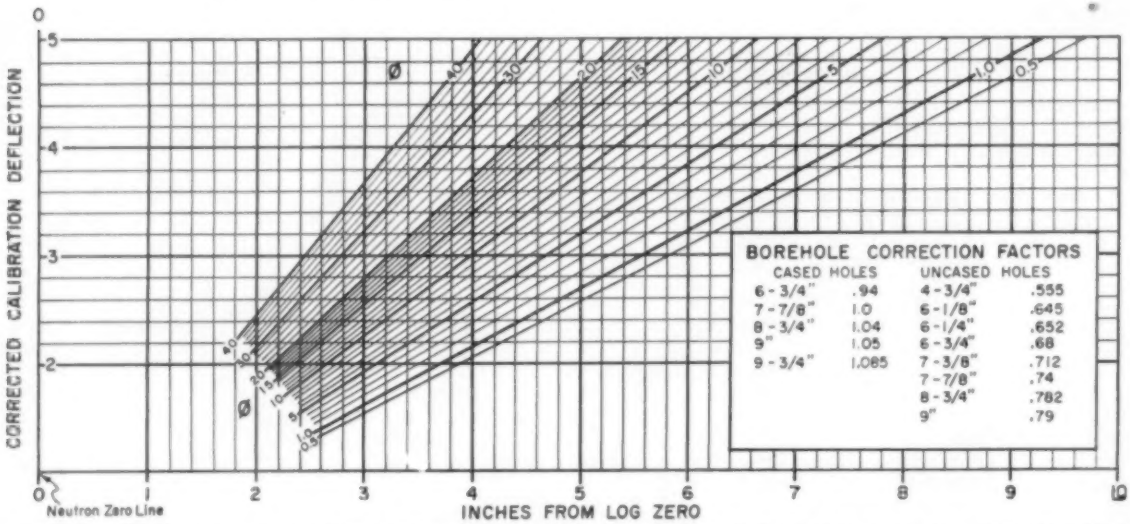


CHART 14—This determines porosity from the neutron-neutron log, for Oklahoma and Canada. It is to be used for nonshaly formations. For holes filled with fluid and logs subsequent to September 1953 use neutron-zero method below. For holes with no fluid use shale-line.

Neutron-zero method:

1. Obtain calibration deflection from heading or bottom of log.
2. Determine appropriate bore-hole correction factor from table of Chart 14.
3. Determination calibration factor divided by bore-hole correction factor. This is corrected calibration deflection (CCD).
4. Draw horizontal line through CCD value of Chart 14.
5. Measure distance from neutron zero to neutron curve. Note: above chart is not to scale. A full-scale chart could be used directly on log and must be used to make transparent rule shown in previous illustration.
6. Read porosity, Φ, direct along horizontal CCD line. A full-scale chart may be folded along this line and neutron log indexed in per cent porosity, or, vertical lines from porosity values can be projected upward or downward to neutron log.

Shale-line method:

1. Establish an average shale line.
2. Establish a line through average of maximum deflections on dense limestones.
3. From Chart 14 select a horizontal line that gives porosities of 0.5 to 40 per cent which will match the maximum deflection line and the shale line on the log. Intermediate porosities can be read directly from this scale. (Note the reduced scale of the above chart.)

Per cent porosity, Φ, may be converted to formation factor, by the Humble formula using Charts 12 or 15 or by the Archie formula using Chart 12.

Caution: On heading of Chart 14 note limits of application of the chart and scale. The chart and scale are for the tool designated LPE-85.

by W. L. Nelson
Technical Editor

QUESTIONS ON TECHNOLOGY

How Crude-Oil Processing Has Changed

What changes in crude oil distillation have taken place and may we expect a large obsolescence of crude-processing equipment in the future? S.G.P.

Although Table 1 here indicates at least 16 significant changes in crude-oil processing, the crude-distillation part of a refinery is now a secondary operation in the sense that it is adjusted to meet the needs of other operations such as cracking or lubricating-oil manufacture.

The major change in processing occurred during 1923-1939 when shell-still batteries were replaced by pipe stills and multidraw towers, followed immediately by the use of combination topping and cracking, and combination topping and lube distillation (two-stage) plants. This is the only clear case of obsolescence among crude-processing operations. Nevertheless, the change took place so slowly and the replacement of shell stills by pipe stills was so profitable that little expense chargeable to obsolescence can be isolated. In addition, small refiners converted many shell stills into salt settlers, fractionating towers, storage vessels, etc., so that scarcely any equipment had to be sold as junk.

Most of the other changes of Table 1 must be classified mainly as additions or improvements.

TABLE 1—CHRONOLOGY OF CRUDE PROCESSING

1865 (1860-1906)	Batch cheesebox or shell stills.
1870 (1865-1910)	Cracking distillation for kerosine.
1890 (1885-1910)	Continuous shell-still battery.
1905 (1900-1910)	Battery with packed towers.
1910 (1900-1930)	Bottom sediment settling still.
1910 (1907-1925)	Coke stills (dry).
1910 (1905-1935)	Cracking distillation for paraffin wax.
1912 (1900-1930)	Peak use of steam in shell stills.
1915 (1910-1930)	Battery with dephlegmators.
1915 (1911-1930)	Pipe stills and perforated plate towers (Calif.)
1920 (1915-1930)	Perforated plate towers.
1930 (1925-)	Vacuum pipe stills and towers.
1930 (1925-)	Pipe stills and bubble plate multidraw towers.
1935 (1932-)	Propane deasphalting for lubes.
1937 (1932-)	Desalting (chemical and electrical).
1939 (1930-)	Combination of topping with other operations.
1949 (1938-)	Vacuum flash towers.
1950 (1944-)	Propane decarbonizing for cracking stocks.

Chronology of Crude-Oil Processing

Although at least 60 coal-distillation plants were in operation between 1852 and 1859 when oil was discovered in the United States, these had never advanced to more complexity than batch distillation stills. So-called cheesebox stills having a flat round bottom were first used in distilling petroleum, and some of these were in operation as late as 1910. Continuous shell-still batteries were suggested as early as 1865 but David T. Day (Handbook of the Petroleum Industry, Vol. II, p. 324) states 1899 as the date of the first continuous shell-still battery. A. W. Nash (J. I. P. Tech., 26, p. 41, Feb. 1940) states 1885 as the date and also mentioned that bubble trays were suggested at the same time. However, many batch stills were still in operation in 1906 (Day, II, 324). Some packed towers were used between 1885 and 1915 (Nash) and dephlegmators or partial condensers (Gray towers) were used between 1900-1920 (Nash). The Gray towers were boxlike constructions with openings from four directions that could be opened to allow the wind to blow through them to cause cooling. Continuous operation permitted the use of heat exchangers, and in many batteries one of the stills was used to separate bottom sediment and water.

Dry distillation was employed until about 1900, and the use of steam reached a peak in 1912. Relatively large steam or power plants were required. Only a few vacuum-shell stills (300-400 mm. Hg) were used. Coking was practiced extensively during 1907-1912 in plants situated close to the steel mills (cheap bottom plate) and close to a suitable market for coke. By 1922 (Day, II, 329) most of the coking stills employed steam.

The heavy crude oils found in California tended to foam during distillation and this led to the development of the Trumble continuous distillation process (Nash) involving the use of pipe stills, separators, and fractionating towers having perforated plates. However, these advances were adopted only slowly throughout the rest of the industry. Pipe stills were used ahead of the first shell still of the battery between 1915 and until after 1930. Bubble towers were installed extensively by 1925 and pipe stills were installed in all new plants after this date. Continuous vacuum (pipe still and bubble tower) stills were developed during 1926-1929, and this operation rapidly replaced the use of steam stills in the manufacture of lubricating oils, although the term "steam refined" persists to this day.

Propane deasphalting has been used to some extent since 1933 in the manufacture of lubricating oils and more recently (1948) as propane decarbonizing in the preparation of feed stocks for catalytic units.

Topping, skimming, or stripping has been relegated more and more to a secondary position since about 1930 when the usefulness of combination topping and cracking (and other combinations) was established. Chemical or electrical desalting equipment was installed extensively during 1935-1940.

Refinery Fuel Cost For Foreign Refineries

In one of your answers you indicated a fuel cost of 17 cents per barrel in U.S.A. refineries. Is this smaller than the cost in foreign plants? F.M.T.

Excecpt for those few foreign refineries that may have cheap natural gas (Middle East and possibly some Venezuelan refineries) or those that may burn a significant amount of coal (in steam generation), the cost of refinery fuel in foreign plants is generally higher than in the United States. This arises because the fuel must be priced, to a large extent, at the price equivalent of residual or Bunker C fuel oil in that region. This is usually about the same as the price of fuel delivered from the U. S. Gulf (or Caribbean area), and in addition many governments impose import duties or special taxes. Thus, during 1955, the cost of refinery fuel (Bunker C fuel oil) in Santos or Rio de Janeiro on such a basis would be:

Price at Caribbean, per bbl.	$2.03
Trans. at USMC—13 per cent	.75
Delivered price, per bbl.	$2.78

This amounts to about 44.1 cents per million B.t.u. or to nearly 28 cents per barrel of crude oil processed rather than the 17-cent cost in the United States. However, the Brazilian currency is regulated and in this instance the price of residual fuel has been lower than indicated here.

Note especially that a higher fuel price for a foreign refinery also means a greater income from residual fuel products. Thus, although the fuel cost may be greater, the greater cost is offset by a larger product income so that operation may be more profitable at a foreign point rather than less profitable.

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Considering replacement power for a boiler of this capacity costs between $7,000 and $15,000 per day, it's easy to see a $50,000 savings. And, it's just as easy to project a $250,000 to $500,000 annual savings for a plant with five to ten such boilers.

This particular case history concerns a power company with a forward-looking operations manager. But, Dowell has other startling performance data to show you — from your own industry. That's because chemical cleaning is so versatile. Dowell engineers are experts in removing scale and sludge from process systems, tanks and piping. They apply solvents in various ways— such as filling, jetting, cascading. Dowell furnishes all the necessary chemicals, trained personnel, pumping and control equipment.

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A SUBSIDIARY OF THE DOW CHEMICAL COMPANY

by Jon A. Vinson
The DATICS Corp.

Using Electronic Computers in the Oil Industry

Part 10

How the Mass Spectrometer Works

IN recent years a new electronic device has come upon the American scene, joining hands with the electronic computer to cause revolutionary strides in the oil and gas industry. This device is familiar to us as the mass spectrometer. When we can understand what the mass spectrometer does, and what it produces for us, we can then understand how valuable this information is when allied with mathematics and high-speed computers.

The mass spectrometer is an instrument for bombarding various substances by a stream of highly accelerated electrons and recording the manner in which they fragmentize. The relative quantities of such fragments form the "mass spectrum" of the substance.

Simple analyses may be solved by one measurement, algebraically subtracting from the spectra of the complex mixtures the spectra of the pure substances. However, more complex problems are solved by numerous measurements known as calibration runs, and solving the resulting set of simultaneous equations.

Since a mass spectrometer is an electronic device making highly critical measurements, there are no two such instruments exactly alike. Thus, the first step necessary is to calibrate a new instrument. This is done by running known pure substances through the instrument. As the mass spectrometer encounters these pure substances it will produce certain readings at a given pressure. We now know that whenever the device encounters this substance, at this pressure, it will record it accordingly. In a sense, we are learning the language of the instrument. Theoretically, once this is done it should be sufficient. However, due to the aging and changing of various parts within the instrument, this "language" will change over a rather long period of time. It should be emphasized that recalibration is the most difficult procedure in the entire operation and it is not done often. Accuracy would range high if recalibration were done only three or four times per year.

Mixture . . . Let us now assume that we are ready to analyze a mixture of two substances, having previously calibrated for each of the substances in pure form. We will call the pure substances A and B, and assume their partial pressures in the mixture to be the unknowns a and b. We will call the two mass settings used X and Y. These two mass settings will yield the peak heights and we shall call them x and y.

Suppose that in previous calibrations we have noted that pure A at mass X has yielded a reading of $x = 1$ and at mass Y has yielded a reading of $y = 3$. In the same light, let us assume pure B has yielded $x = 2$ and $y = 4$. This will yield the equations:

$$1a + 2b = x$$

$$3a + 4b = y$$

We know we can readily measure x and y on the machine. If we can rearrange these equations in terms of x and y, yielding a and b, we will have our solution.

At this point we introduce a mathematical technique known as matrix inversion, which is used to solve systems of simultaneous equations.

What we define as the matrix are the four coefficients of a and b as they appear in the equations:

$$\begin{pmatrix} 1.0 & 2.0 \\ 3.0 & 4.0 \end{pmatrix}$$

Through inversion, we arrive at the inverse matrix:

$$\begin{pmatrix} -2.0 & 1.0 \\ 1.5 & -0.5 \end{pmatrix}$$

We can now take these coefficients and write the equations:

$$-2.0x + 1.0y = a$$

$$1.5x - 0.5y = b$$

These equations may be used many times when analyzing mixtures of substances A and B.

The above example is relatively simple and could be easily performed on a desk calculator in a matter of seconds. Unfortunately, it is invariably more complicated. In actual practice field samples of mixtures are often found to have 5, 10, 20, or more components in the mixture. The inversion of a matrix roughly requires about N^3 multiplications and N^3 subtractions, where N is the number of components in the mixture. In the above example it can be seen that this involves eight multiplications and eight subtractions. However, let us suppose the original matrix is a 20 X 20 with each numeric component consisting of 10 digits. This would mean an array of 400 ten-digit numbers in which it would be necessary to perform 8,000 multiplications and 8,000 subtractions. Dealing with 10-digit numbers, it would probably take the average desk calculator operator months to solve a problem of this complexity.

Electronic computer . . . At this point we introduce the mass spectrometer's inseparable ally, the high-speed electronic computer. The digital computer can perform matrix inversion, accurate to 10 places, in times ranging from a few seconds to a maximum of minutes. Present-day computers will invert a 20 X 20 in from 5 to 7 minutes. Once this inversion is performed, it is not necessary to repeat the process for this specific group of components unless recalibration is performed. This inverse is recorded on punched cards or tape, and from that time on it is only necessary to run a given mixture on the mass spectrometer, enter the observed peak heights into the computer, and multiply by the previously computed inverse. This is a simple mathematical process which requires less time for computation than for printing the answers on a mechanical-output device.

Thus, through the alliance of two of our more important modern-day scientific instruments, it is possible to have a complete percentage breakdown of all the components contained in a mixture within 3 or 4 minutes after the sample arrives from the field.

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5618-R

by J. L. Cottrell

REGULATORS, METERS, AND INTEGRATORS

Last of Three Parts

Electronic Counter Speeds Chart Integration

THERE are various makes of satisfactory integrating orifice meters, however, they are seldom used on casing-head measurement. The two-pen mechanical integrator, originally designed and manufactured by J. B. McGaughley, is a mechanical device using the square-root cam principle. The pressure and differential pens are operated manually to follow the pressure and differential lines. Using this method, multiply the instantaneous square-root values of both the absolute pressure and the differential, and accumulate a total for the particular time period of the chart.

This extension or total integration can be multiplied by the orifice coefficient, corrected for other factors that effect the flow, such as contract pressure base, specific gravity, flowing temperature, and on higher pressures as designated in some cases by state regulation, the supercompressibility and Reynolds factors, where applicable, to arrive at the total volume. Fortunately, in casing-head measurement, supercompressibility, Reynolds and expansion factors are negligible and can be ignored.

Casing-head charts . . . These charts, due to the paramount desire of all operators to get the maximum number of gallons for every thousand cubic feet, are usually difficult to read. The pressure and differential vary all over the board. Therefore this is why the integrator is the fastest and most accurate method of reading these rough or heading charts.

Striking an average on the pressure and differential lines for an hour or 24-hour period usually would result in a high reading. You would be taking the square root of the average and the desired result in the instantaneous average square root of both the pressure and differential lines if this method were used.

The author is with Flow Measurement Co., Inc., Tulsa. Paper presented at the N.G.A.A. regional meeting at Shreveport, La.

Reading charts . . . The question of where to read printed lines on differential has always been a problem. Good practice would be to trace the wide differential line with the integrator pen approximately one-third from the bottom to the half-way point. The lower the differential, the more advisable it would be to read only one-third up from the bottom of the line.

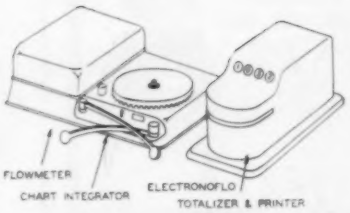
Some companies install 15-minute, 1-hour, or other rotation less than 24-hour charts, on severe installations, to determine whether most of the fluctuation is at the bottom of the line or at the top of the line.

When integrating charts on which the differential pen follows a distinct flow pattern, and it is possible to follow these lines, it is advisable to do so particularly if there is a sizable volume represented on the chart.

The question arises of how close should a gathering system check with the master meter—in many cases, the field meters are 7 and 8-day rotation. On varying flows this causes more difficulty in reading the charts. The temperature and specific gravity also will vary on field meters, whereas the master meter often has a recording thermometer and recording gravitometer and usually uses the 24-hour chart.

In field meters balance with the master meter within 1 to 5 per cent, a good job is being done. However, there are cases where extreme fluctuating flows will make it impossible to check that close.

Recording gas gravitometers . . . These have a place on the master check meter or sales meter. They insure proper corrections of variable gravity insofar as measurement is concerned. And they will tell you if you have any products going into the gas company's line. Therefore, we have a check on recovery efficiency at the plant.



ELECTRONIC TOTALIZER and printer accumulates the chart integration, prints the total integration of each chart, and clears out.

Standardize Chart Travel

We have all been confronted with running out of charts or not having the correct make for the meter we are using. In the interest of standardization, it would be a good idea to standardiize on an orfice meter chart travel for all makes of meters.

Now, the only thing that is standard on all makes of orifice meter charts is the ½-in. center hole. We have the A.G.A. Report No. 3 setting out detailed specifications for design of orifice plates, meter tubes, and other data, but we don't have a standard chart radius. We have standards for face-to-face dimensions on valves and other products. The petroleum industry is interested in the face-to-face dimensions on a valve only when it is installed in the line. We are interested in the radius of the chart every time we change the chart on the meter.

Electronic counter . . . There is a new development for the integrator which eliminates the mechanical dial counter. This electronic counter accumulates the chart integration, and when completed, prints the total extension or integration of each chart on the back of the chart. It clears out, eliminating the necessity of balancing out the dial-counter differences, and checking the operator for transposition of figures. This unit will speed up chart integration approximately 25 per cent. This development will further eliminate the friction loss caused by the drag in the mechanical counter. **End.**

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97 Twisting Cap

97 Adapter

No. 97 Ever-Tite Fill Cap

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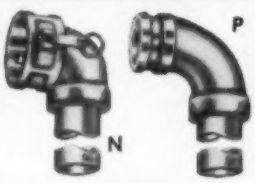
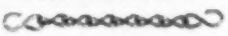
EVER-TITE ADAPTER AND COUPLER FOR TANK CAR UNLOADING



EVER-TITE 90° FULL-FLO ADAPTER AND COUPLER

Drop Tubes or Pipe Threads

EVER-TITE DUST PROTECTORS



Chain for attaching Dust Caps or Dust Plugs to adapters or couplers

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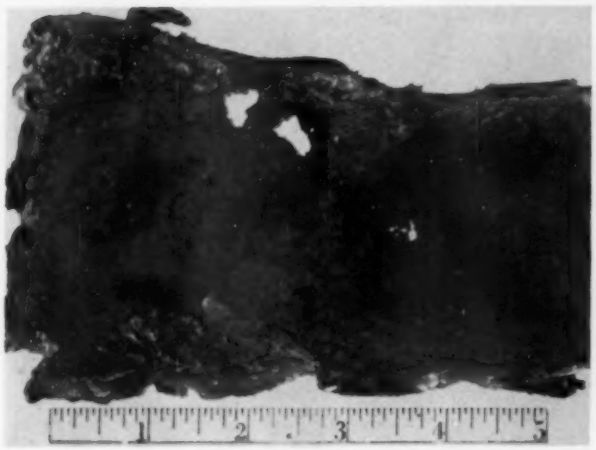
Part 8

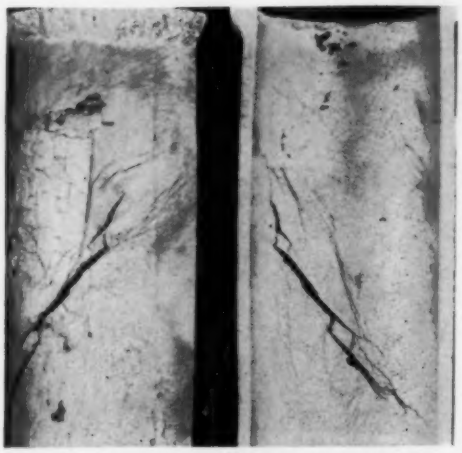
Corrosion of Ferrous-Metal Tubing

How to Prevent Stress Corrosion Cracking

by Thomas M. Krebs



INLET end corrosion of carbon-steel tubing from a crude heater. Fig. 17.



STRESS-CORROSION cracking of Type 347 tube at both inner and outer surfaces. Fig. 18.

EROSION-CORROSION problems result from the combination of corrosion plus the mechanical sweeping away of the corrosion products by a high-velocity stream with associated metal loss. This is common at bends or at the inlet ends of heat exchanger or refinery heater tubes.

Fig. 17 shows severe inlet end corrosion in a section of carbon-steel tubing from a crude heater after about 2 years service. Sulfur compounds in the presence of water emulsified with the oil resulted in corrosion with the formation of sulfates. Temperatures at this location were of the order of 150° to 300° F., and it was noted that little corrosion occurred above this temperature where aqueous solutions would not exist. Safe-ending with a more resistant alloy or more effective crude treatment normally provides a remedy.

Stress-corrosion cracking as the name implies also belongs to the mechanical-chemical type of corrosion. Many materials are subject to stress corrosion cracking in some critical environment but for the ferrous materials the most familiar occurrence in refinery situations is the cracking of austenitic stainless steels in chloride-bearing environments. Sometimes accompanied by chloride pitting, this type of cracking occurs transgranularly and usually with little actual metal loss.

Accepted methods . . . Consequently, the generally accepted methods by which corrosion rates are reported as weight loss or penetration per year are of no practical value in design under conditions where cracking occurs. A classic illustration is shown in Fig. 18 in which stress corrosion cracks initiated at both the inner and outer surfaces of a Type 347 tube. This tube formed the outlet section of a Thermofor kiln-cooling coil.

Concentration of chlorides in the cooling water led to stress corrosion cracking from the inside while leaching of magnesium chloride salt from the wall refractory during shutdown led to severe o.d. cracking of the tubing and an attached chrome-nickel identification tag as well. In this case stresses were largely of thermal origin but they may be from any source such as bending, welding, straightening, fluid pressure, etc.

Reduction of chlorides . . . Corrective measures in these cases usually involve reduction or elimination of chlorides, design modifications to lower stresses, stress relief by heat treatment, the use of nonsusceptible ferritic stainless or in extreme cases the acceptance of greater corrosion of the nonsusceptible leaner alloys or carbon steel.

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Next . . . The next article in this series will contain information on intergranular cracking and a summary of the entire series.

Author is metallurgist, Tubular Products Division, Babcock & Wilcox Co. Article presented at Western Petroleum Refiners Association meeting, Wichita.

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Pipelines look for superior toughness and . . .

Special steels meet requirements

Modern methods produce steel that is weldable without preheating with 100 per cent weld-joint efficiency

IN the future, special steels with superior toughness characteristics may be desirous for pipelines operated at subzero temperatures or near pumping stations and in densely populated areas. The special steels to be discussed are weldable without preheat and have a weld-joint efficiency of 100 per cent. Quenched and tempered steels do not normally meet this requirement and, therefore, hot-rolled or normalized steels are involved.

Factors considered . . . Killed steels in general have superior toughness characteristics and less segregation compared with semiskilled or open steels. Also, for pipe made from skelp or plate, cross rolling is a desirable practice with reference to the transverse properties of the material.

Consideration of chemical composition involves lower levels of carbon with increased manganese in the carbon-manganese steels. The use of alloy additions other than manganese permits levels of carbon with normal manganese contents. Lower carbon not only improves the toughness characteristics, but also weldability. With a balanced chemical composition in low-alloy line-pipe steels, it should be possible not only to achieve toughness characteristics and weldability without preheating, but in addition, a higher strength level than can be achieved with the carbon-manganese steels.

In the manufacture of many line-pipe steels, cold expansion of the finished pipe is employed. This treatment increases the transverse tensile strength properties but does not enhance the toughness characteristics of the material. Therefore, in the manufacture of special line-pipe steels, the amount of cold work is limited, although it does not adversely affect the weldability characteristics of the material.

Finally, to improve the toughness characteristics, the effect of a normalizing treatment should be considered. Usually, line-pipe steels are used in a hot-rolled or cold-expanded condition. The normalizing of aluminum killed steel not only produces uniform properties and a small uniform grain size, but also brings about a certain amount of fixation of nitrogen in the steel which is desirable with respect to the toughness characteristics of the material.

Steel research . . . In order to evaluate the characteristics of line pipe as outlined, a cooperative experimental program is in progress with Bechtel Corp., A. O. Smith Corp., United States Steel Applied Research Laboratory at Monroeville, American Bridge Division, Consolidated Western Steel Division, and National Tube Division. Low alloy Tri-Ten steel, for example, is being investigated. This steel in the form of plate, is usually provided in the as-rolled condition with a minimum yield strength of 50,000 psi.

When manufactured into pipe and cold expanded, the minimum yield strength properties may approach 60,000 psi. Preheating normally is not required in welding. The steel is resistant to atmospheric corrosion. A plain carbon steel and the Tri-Ten steel in the as-rolled and normalized conditions being investigated are shown in Table 1. Pipe diameters are 20 and 26-in. o.d. with 0.375-in. wall and the test pipe was manufactured by the submerged-arc welding and expanding process.

In this investigation, girth welds will be tested. Tensile, bend, X-ray, Magnaflux, Charpy V-notch, underbead cracking, burst, and hydraulic-ring-expansion yield-strength tests will be conducted. The properties of killed steel and normalized steel will be evaluated in terms of the toughness of the pipe material. Line pipe with minimum-yield strengths exceeding 52,000 psi. are under development in addition to lower-strength steels with superior toughness characteristics.

In high-strength low-alloy constructional steels used for structural purposes, it is usually necessary to provide for corrosion resistance by alloy addition. This is because of the decrease in thickness of the high-strength material and atmospheric conditions. Pipelines are vulnerable to the corrosive attacks of soil and not atmospheric conditions, except in special cases.

A coating of asphaltic or coal-tar pitch incorporated with a spiral wrapping of glass cloth is used frequently. Corrosion inside the pipeline is controlled by proper treatment of the gas or liquid being transported.

In the development of special line-pipe steels, corrosion is not considered an important factor because of exter-

Material from a paper by A. B. Wilder, chief metallurgist, National Tube Division, U. S. Steel Corp., presented at annual A.S.C.E. meeting, Pittsburgh, October 16, 1956.

TABLE 1—CHEMICAL COMPOSITION OF SPECIAL LINE-PIPE STEELS

Brand or type of steel—	O.D. in.	Chemical composition, per cent— C	Mn	Si	Cu	V	Ni
ASTM A201—killed	20	0.18	0.76	0.22	....	....	....
TRI-TEN—killed	20	0.18	1.11	0.19	0.46	....	0.54
TRI-TEN E—semikilled	26	0.22	1.00	0.06	0.22	0.05	....
TRI-TEN E—killed	26	0.21	1.28	0.21	0.23	0.05	....

TABLE 2—CHEMICAL COMPOSITION AND TENSILE PROPERTIES OF GRADE X110 LINE-PIPE STEELS

Type	Pipe size	Chemical composition, per cent— C	Mn	Ni	Cr	Mo	V	Cu	B	Yield strength psi.*	Ultimate strength psi.	Elongation in 2-in. %
C-Mn	9⅝-in. o.d. 0.472-in. wall	0.27	1.23	....	....	....	....	....	....	128,000	140,000	22
C-Mn	9⅝-in. o.d. 0.472-in. wall	0.33	1.35	....	....	....	....	....	....	119,000	133,000	21
"T1"	6⅝-in. o.d. 0.250-in. wall	0.13	0.85	0.91	0.58	0.44	0.055	0.34	0.0026	118,000	128,000	22
"T1"	8⅝-in. o.d. 0.250-in. wall	0.15	0.86	0.86	0.59	0.41	0.055	0.35	0.0026	116,000	124,000	23

*0.6 per cent elongation under load. Specimen 1½ in. wide; P, 0.05 per cent max.; S, 0.06 per cent max.; Si, 0.10/0.30 per cent.

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nal protective measures and treatment of the gas or liquid transported.

Due to the increased cost of the steels being developed and the limited production facilities available for the special treatments required, the use of these special steels will be limited.

110,000-psi. pipe . . . Line-pipe steels with 110,000 psi. minimum-yield strength (grade X110) consist of tempered martensite. In the untempered state, martensite has long been considered brittle and this has led to the long-standing reluctance of design engineers to permit the use of a quenched product.

More recently with increasing need for higher-strength materials, metallurgists have reexamined martensite. They have found that the low or medium-carbon variety in the tempered condition may have high-shock toughness and resistance to crack propagation with high-strength properties.[1]

This new concept of toughness, the toughness of low and medium-carbon tempered martensite, has provided a new material for pipeline construction. This material should make it possible to use smaller-diameter pipe at higher pressure. The economic advantage to be gained, however, remains to be demonstrated.

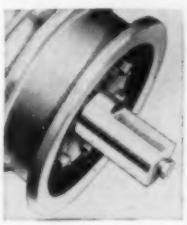
Special steels . . . High-strength seamless line pipe with 110,000-psi. minimum-yield strength has been experimentally produced from quenched and tempered steel. Two types of steel have been employed for the experimental tests; namely, (1) USS "T_1" low-carbon tempered martensite steel, and (2) medium-carbon tempered martensite C-Mn steel. The chemical composition and mechanical properties of the steels are shown in Table 2.

T_1 steel is the toughest steel which has been developed for line-pipe application and may be welded with weld-joint efficiencies approaching 100 per cent. A high-strength weld electrode is required. The properties of T_1 steel are due in part to the alloy additions making possible low-carbon martensite and the vanadium content of the steel which enhances the strength of the weld heat-affected zone. Due to the cost of alloy additions in T_1 steel, a lower cost C-Mn steel has also been developed with 110,000-psi. minimum-yield strength. Tests indicate that this C-Mn steel should be satisfactory for many line-pipe applications.

Experimental welding electrodes . . . Utilization of low-hydrogen Type E120XX lime electrodes for field-welding grade X110 line pipe has been investigated. The use of the low-hydrogen electrodes offers the advantage of eliminating preheating and underbead weld cracking. In addition, Type E120XX electrodes with powdered iron in the coating were investigated for line-pipe welding. The advantage of electrodes with powdered iron is in the increased deposit rate. The results also indicated that a regular Type E10010 cellulose-coated electrode with preheating is satisfactory for welding grade X110 line pipe.

Cracks were not encountered with the low-hydrogen electrodes and preheating was not required. The difficulty in welding was due to the entrapped slag which caused unsound welds. This was particularly observed when downhill welding was employed. Unsound welds were also obtained with the electrode containing powdered iron in the coating. These welds were preheated. In the experimental work, various combinations of weld electrodes were employed. For example, a low-hydrogen electrode was used for the root bead with the remainder of the weld of cellulose electrodes. Cellulose electrodes were also used in the root bead and a low-hydrogen electrode for the remainder of the weld. The various combinations of weld electrodes did not overcome the objections to the low-hydrogen and powdered-iron electrodes. The objections were associated with unsound welds, particularly when downhill welding was employed.

Weld strength . . . Under proper welding conditions the Type E120XX special lime electrodes used in this investigation which deposit weld metal with a minimum tensile strength of 120,000 psi. are satisfactory for welding plate material. The technique used in pipeline welding, however, adapts itself to the cellulose types of electrode as pipeline welders use downhill practice. The cellulose electrode employed in this investigation was Type E10010 and deposited weld metal with a minimum tensile strength of 100,000 psi. For welding grade X110 line-pipe material, a Type E120XX cellulose electrode would require development with minimum tensile properties of 120,000 psi. and should be used in the field. A preheat of 350° F. with the cellulose electrode was satisfactory for welding the grade X110 T_1 steel and C-Mn steel and a similar preheat should be



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satisfactory for a Type E120XX cellulose electrode.

In welding quenched and tempered C-Mn line pipe, the lower strength of the weld heat-affect lowers the longitudinal tensile strength across the girth weld. This condition may be improved with a cover bead of the proper shape which reinforces the weld heat-affected zone. Burst-test results indicate the lower strength of the weld heat-affected zone of the girth weld does not lower the bursting strength. This is due to the narrow width of the heat-affected zone. The strength of the weld heat-affected zone of T_1 steel girth welds is similar to the original quenched and tempered material which has not been welded. The longitudinal tensile properties of T_1 welds are, therefore, satisfactory and no special problems would be encountered which are related to this property.

In girth welding grade X110 line pipe, the use of 300° F. preheat may be used for the root pass followed with a hot pass. A 300° F. preheat should also be used for the filler pass followed by a hot-pass completion of the remainder of the weld. This procedure involves two preheating treatments and the use of a Type E120XX cellulose electrode. In addition, the cover or face bead should be of sufficient width and height to strengthen the weld heat-affected zones associated with the root and filler weld beads.

Other steels . . . In addition to quenched and tempered steels for 110,000-psi. minimum-yield strength, there are other steels which may be considered. These are air-hardening alloy steels in the normalized or stress-relieved condition. Due to the higher carbon content of these special steels, the problems encountered with welding require very special consideration. The yield strengths to be obtained would exceed 75,000 psi. but would not equal the quenched and tempered products.

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1. Aborn, R. H.: "Low Carbon Martensite," Transactions, American Society for Metals, Vol. 48, p. 51, 1956.

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SYMPOSIUM ON SPECIFIC GRAVITY OF BITUMINOUS COATED AGGREGATES, published by American Society for Testing Materials, 1916 Race Street, Philadelphia 3. Paper back. 71 pp. $2; to members, $1.50.

This symposium contains information about: (1) specific gravity in the design and control of bituminous paving mixtures, (2) measurement of bituminous concrete core specific gravities and specific gravities of bituminous coated coarse aggregates by means of a volumeter, (3) measurement of maximum theoretical specific gravity of a bituminous mixture by solvent immersion, (4) maximum specific gravity of bituminous mixtures by vacuum saturation procedure, and other subjects concerning bituminous coated aggregates.

CONTROL OF STEEL CONSTRUCTION TO AVOID BRITTLE FAILURE, edited by M. E. Shank. Published by Welding Research Council, 29 West Thirty-ninth Street, New York 18. 184 pp. $4.50.

For several years the Plasticity Committee of the Welding Research Council has been working on the preparation of a manual which would analyze researches dealing with the notch sensitive properties of structural steel and summarize available information and data of significance in design and construction.

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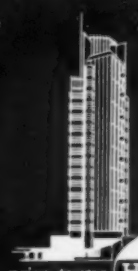

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Among the Drilling Contractors

Milton Crow, Inc., Shreveport, is on a 7,000-ft. Travis Peak test 1½ miles west of Lake Bistineau, in southeastern Bossier Parish, North Louisiana. The test, 1 Horton, in 11-16n-11w, is being drilled for Crow's own account.

Dillard & Waltermire, of Houston, will drill a deep test for Charles B. Wrightsman, also of Houston, at a wildcat location southeast of West Gueydan field, in northwestern Vermilion Parish, Coastal Louisiana. The test, 1 Vermilion Parish School Board, is in 16-12s-2w.

Lawton - Partee Oil Co., Magnolia, Ark., has taken on a 9,500-ft. contract operation in western Columbia County, southern Arkansas. It is drilling for Trice Production Co., of Longview, Tex., at 1 G. W. Dorman estate, in 26-17s-23w. Location is 3 miles southeast of McKamie, and about 1¾ miles east of McKamie-Patton field. Smackover lime is the objective.

Gulf Coast Drilling & Exploration Co. is in with Dave Gammill on the drilling of a deep wildcat test 3 miles northeast of Taylorsville, in Smith County, southern Mississippi. Hole is to be carried through the Rodessa and Sligo zones productive in the prolific Soso field, 7 miles southeast. Projected depth is 12,500 ft. The test is listed as 1 Easton with spot location in Lot 14, 4-10n-14w. California Co. has drilled three deep tests in the area.

New Drilling Co., Denver, is drilling on a new Shell Oil Co. wildcat test in Sandoval County, northwestern New Mexico. Location is at 1 Hall, in 35-21n-5w, 15 miles south of Largo Canyon.

Sooner Well Service Co. is drilling a 6,000-ft. Sinton-sand test for Dave Krause and Coastal Trend Oil & Gas Corp. in the East Plymouth area, 6 miles northeast of Taft, in San Patricio County, South Texas. Location is at 1 Russell, in Section 36, Taft Farm Lands Fourth Addition.

Pyburn Drilling Co., Shreveport, has a rig working for Robert F. Roberts, of Tyler, Tex., in the Killens Ferry area, Tensas Parish, eastern Louisiana. It is on Roberts' 1-D Ayer Timber, in 1-13n-9e, about 1½ miles southwest of production. Contract is for a Tuscaloosa test with depth of about 6,995 ft.

Circle Drilling Co., Lake Charles, La., has two new contract jobs going in South Louisiana. One is 12,000-ft. test for Vincent & Welch and Charles B. Wrightsman in northwestern Vermilion Parish. Location, at 1 Somon, in 31-11s-1w, is about 2 miles west of

MERGER PRINCIPALS—W. O. White (left), president of Trans-Tex Drilling Co., of Shreveport, watches as George S. Buchanan, Trans-Tex board chairman, and H. L. Rowley, board chairman of Rimrock-Tidelands, Inc., New Orleans, meet following ratification by their respective directors of a proposed merger of the two drilling companies (The Oil and Gas Journal, May 13, 1957, page 91). White becomes vice president of land and production; Buchanan, board chairman; and Rowley, president, of the merged organizations which will operate under the Rimrock-Tidelands name. W. C. Kneale (not present), now president of Rimrock-Tidelands, will be vice president in charge of exploration.

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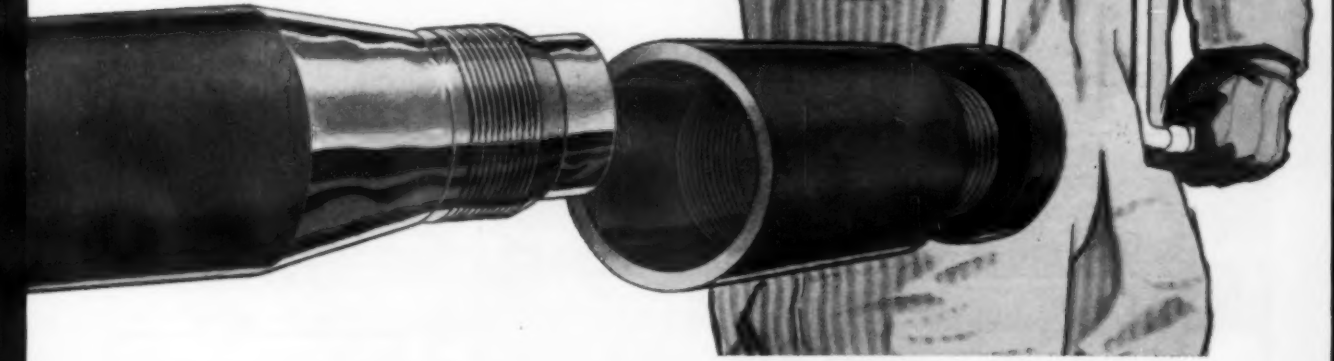

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Gueydan field. The other is a Frio test for Bradco Oil & Gas Co. and Texas Eastern Transmission Co. at 1 Zaumbrecher, in 11-8s-1w, northeast of Grand Coulee field, in northern Acadia Parish.

Hayden Farmer Drilling Co. is contractor on a 5,000-ft. Woodbine test I. P. LaRue and W. C. Perryman, of Athens, Tex., are starting in eastern Henderson County, East Texas. Location, on the Brintley and Alexander estate, in the J. S. Johnston Survey, is about 6 miles south of Brownsboro.

C. B. Webster Drilling Co., Houston, has contracted with Southern Natural Gas Co. for another deep well in the new Montegut field, 15 miles southeast of Houma, in Terrebonne Parish, southeastern Louisiana. Permit lists the well as 1-C Waterford with a depth objective of 13,600 ft. Location is east of a newly completed extension well, oil-productive from a 12,200-ft. sand.

Buster-Gardner Drilling Co., Houston, has the contract on another deep well Union Oil Co. of California will drill in the Caillou Island area, in Timbalier Bay, Terrebonne Parish, Louisiana. Union's latest job is at 6 State Lease 2826, a 12,000-ft. test. **Dixie Drilling Co.,** Dallas, also has a rig working for the Union in the same area. Its operation, 4 State Lease 2826, has been delayed by a fishing job with bottom at 12,759 ft.

Richardson & Bass, of Dallas, are on another well Signal Oil & Gas Co. is starting in the South Lake Charles area, 6 miles south of Lake Charles, in Calcasieu Parish, southwestern Louisiana. Location, at 1 Lawton, in 8-11s-6w, is a west offset to Signal's newly completed extension and deeper-pay discovery well. The latter well drilled to 13,826 ft. Its gas-condensate pay is perforated at 13,261-67 ft. The Lawton well is set up to go to 14,000 ft.

Gibson Drilling Co., Kilgore, Tex., has a new wildcat operation in southwestern Smith County, East Texas. It is set up as a Woodbine test with objective about 6,000 ft. Location is off the west side of Whitehouse salt dome, 4½ miles west of Whitehouse, and about 6½ miles south of Tyler. It is drilling for Eugene Talbert and Jim Gulley, of Tyler. Spot location is in the Jesse Kennedy Survey. Gibson also is scheduled to drill a 4,900-ft. Woodbine test for Purnell & Coleman, of Kilgore, at 1 Tipton, in the Gillington Chism Survey, west of Lone Star, in northeastern Cherokee County.

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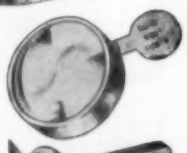

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SHOWCASE...

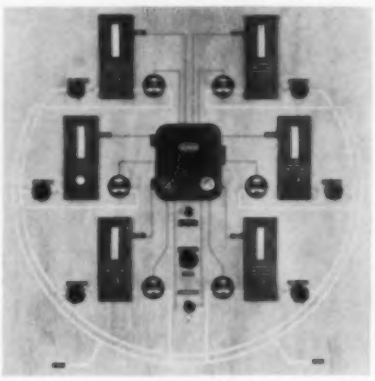
NEW EQUIPMENT

Utility Ditcher Has Foot-Pedal Steering

Features of particular interest on this improved Gar Wood Buckeye Model 403 utility ditcher include: (1) foot-pedal steering. (2) a shiftable spoil conveyor, and (3) hydraulic controls. Specially designed for stop-and-go utility ditching, the ditcher is equipped with a hydraulic pump that provides pressure for instant control of the digging boom.

The foot-pedal-steering arrangement replaces hand levers, providing the operator with greater control and accuracy. A slip clutch automatically protects the machine from overloads.

The shiftable spoil conveyor requires no tools or complicated adjustments to shift it to the right or left. The Model 403 has a maximum digging capacity of 5 ft. deep and 12 in. wide, or 4 ft. deep and 16 in. wide. **Write or call: Gar Wood Industries, Inc., Wayne, Mich., for details on Model 403 ditcher.**

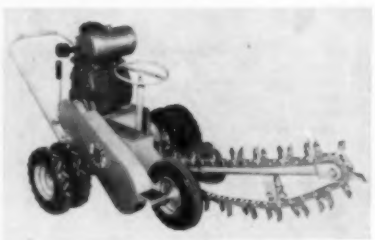


Tank-Selector System Automatically Fills Tanks

Developed for filling storage or settling tanks in tank farms, refineries, or petrochemical plants, this new automatic - tank - selector (ATS) system uses a pneumatic circuit, with a selector-controller and level transmitters directing the operation of pneumatic fill valves.

In operation, the selector-controller automatically senses the liquid level of each tank in the system through the level transmitter. It then automatically opens the fill valve, if the tank requires filling. Or it automatically cycles to the next tank, if filling is not required.

Each circuit can handle up to 12 tanks. And two or more selectors can be connected in series to control any number of tanks. **Write or call: Mason-Neilan, Div. of Worthington Corp., 60 Nahatan Street, Norwood, Mass., for details on automatic-tank-selector system.**



Trenching Machine Cuts 1½ to 6 Ft. Per Minute

This new mobile Model M Ditch-Witch trencher has three forward digging speeds and a reverse plus road

Send this **Showcase Coupon**

to the **Manufacturer** of the item in which you are interested. See name, address, and equipment name and/or model, in bold-face type at end of description.

NAME AND/OR MODEL NUMBER .....

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SINGLE TRAILER MOUNTED MASTS
86 ft 94 ft. 97 ft. 97 ft. Heavy duty
100 ft. 126 ft. Export Model

DUAL TRAILER MOUNTED MAST
97 ft. 100 ft. 126 ft. 126 ft. Export Model

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Dresser Couplings provide the "give and take" necessary to absorb vibration, settlement and other stresses. Specially compounded rubber gaskets permit up to 4° deflection at joints — yet with Dresser Couplings, these joints stay permanently tight.

The only tool you need is a wrench — pipe threading is not necessary. Any workman can install Dresser Couplings, averaging only two man-minutes per bolt.

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A 16" Dresser Coupling on a water jacket in a field processing plant

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Style 38 Coupling

Style 40 Long Sleeve

Hydrepair® Asbestos Cement Pipe Clamp

Style 63 Expansion Joint

Style 39 Insulating Coupling

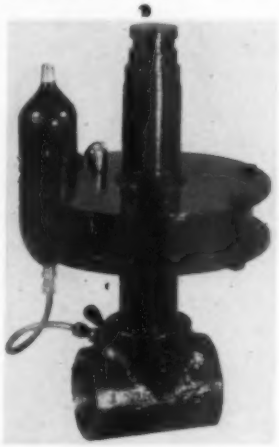
New Equipment

speeds up to 5 m.p.h. In usual digging conditions, the Model M will trench at speeds of 1½ to 6 ft. per minute. It is also equipped with a trailer hitch for towing at speeds up to 25 m.p.h.

Trenching widths and depths available on this machine are: 3 in. wide and up to 48 in. deep, 4 in. wide and up to 36 in. deep, and 6 in. wide and up to 30 in. deep. The digging chains are quickly interchangeable on the job.

When digging, all spoils are deposited on one side of the trench, leaving the other side clear for access to the trench. The Model M may also be used for undercutting sidewalks.

The Model M, the maker says, is especially suited to such applications as digging service lines and gathering systems for oil and gas pipelines. Powered by an 8-hp. air-cooled engine, it's equipped with sealed ball bearings. The Model M weighs 500 lb. **Write or call: Charles Machine Works, Inc., Perry, Okla., for details on Model M trencher.**



Motor Valve Uses 10-Psi. Pilot Pressure

The balanced-pressure design of this McMurry Type MV - NC (normally closed) motor valve is said to allow a full 1-in. opening, if desired, while at the same time maintaining a small, compact tool. Also, the balanced construction allows the use of low pilot pressure (10 psi.), making Bourdon controls more sensitive.

In addition to the normally closed type, the motor valve can be obtained in a normally open type. The motor valve does not require a shaft through the center of the seat section, either in the normally open or normally closed type. The flow of gas or liquid is routed through the tool from the top of the seat. According to the compa-

ny, these two features assure longer-than-average seat life.

The motor valve is simple to service, and all parts are easily replaced, if necessary. **Write or call: McMurry Oil Tool Specialties, 1020 Houston Avenue, Houston, Tex., for details on Type MV-NC motor valve.**

•

Drip-Trap Valve Designed For Heater-Treaters

Designed for low - pressure - volume tanks on heater-treater installations, this new Enardo Model 529 drip-trap valve features a positive leakproof shutoff, the maker states. In the event of a high fluid level in the drip trap, the valve will not reopen until the excess fluid is drained from the trap.

Small lead weights attached to the float arm compensate for buoyancy differential of fluids. Weighing about 6¾ lb., the valve is 9 in. long and its float diameter measures 7 in. **Write or call: Enardo Mfg. Co., 2729 Sand Springs Road, Tulsa, Okla, for details on Model 529 valve.**

•

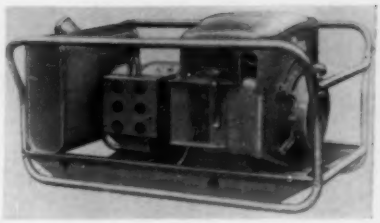
Servicing Rig Permits Pulling Pipe in Doubles

This new Welter Weight well-servicing rig is a fast-tripping doubles rig with the light weight and mobility normally associated with singles rigs, the maker says. The rig can service wells from 2,000 to 10,000 ft. deep.

The draw works, powered by an individual engine with a torque-converter drive, can be rigged up in minutes. The mast is hydraulically operated.

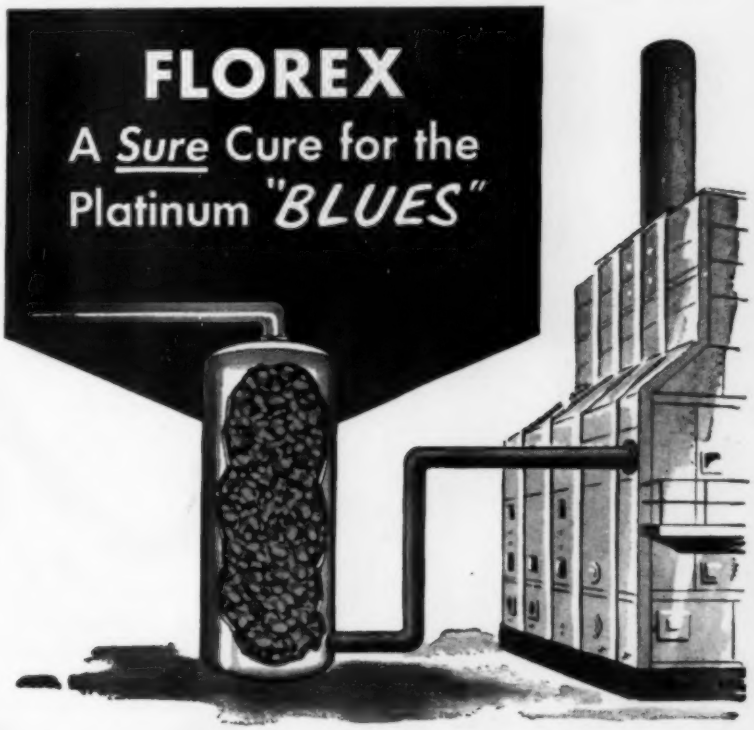
The maker reports a 10,000-ft. round trip with 2-in. tubing can be made in 5½ hours. The tripping system is similar to that used in pulling and handling sucker rods. The tubing is pulled a joint at a time.

By using a hydraulically powered auxiliary elevator and power tongs, the pipe is broken out and racked by the floor men while the traveling block is in motion. This action allows the pipe to be pulled, or run, as fast as the elevators can be raised and lowered. Providing fast tripping, the rig has a weight and dimensions within the legal limit for highway travel. It is said to be adaptable for most workover and still mobile enough for well-service jobs of any depth. **Write or call: Skytop Rig Co., P. O. Box 529, Victoria, Tex., for details on Welter Weight rig.**



D-C Plant Provides 5,000-Watt Power Source

This new lightweight portable 5,000-watt d.c. generating plant can be useful



The growing use of platinum catalysts in reforming feed stock emphasizes the importance of pre-removing trace metals such as arsenic, lead and sulphur compounds. Platinum catalysts are poisoned by these substances in quantities even as small as ten parts per billion.

Treating the feed stock before the trouble occurs, Florex adsorbent provides the simplest, most economical means to protect expensive catalysts. Florex in the granular grades will completely remove or reduce these compounds to a harmless level.

Recognized throughout the world as superior to all other natural clays, Florex is prepared from carefully selected Florida Fuller's Earth by a special processing, including high pressure extrusion.

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unit barrel pumps

In the age of the atom, marvels have become commonplace, but one of its marvels has made it possible to fabricate the uncommonly fine Oilmaster Unit Barrel. It has only been known in recent years that certain iron base alloys rich in nickel would undergo a structural change when subjected to extreme cold—a permanent change in the crystalline structure which improved the hardness and abrasion resistance of the alloy, but more important, caused the alloy to grow, and retain a permanent growth when it returned to atmospheric temperature.

This knowledge paved the way for the development of the Oilmaster Unit Barrel*, where a special analysis of centrifugally cast Ni-Hard is accurately machined into sections which are expanded into a precision honed alloy steel jacket and transformed into an integral unit by application of refrigerant at temperatures of more than 100° below zero.

But atom age or not, only the oil well can tell the difference—and the oil well has shown the Oilmaster Unit Barrel to be beyond question the finest pump barrel that has been produced. If you want to flash a smug smile when the conversation turns to lifting costs, call your Oilmaster Representative and ask him to equip all your hard-to-pump wells with Unit Barrel Pumps.

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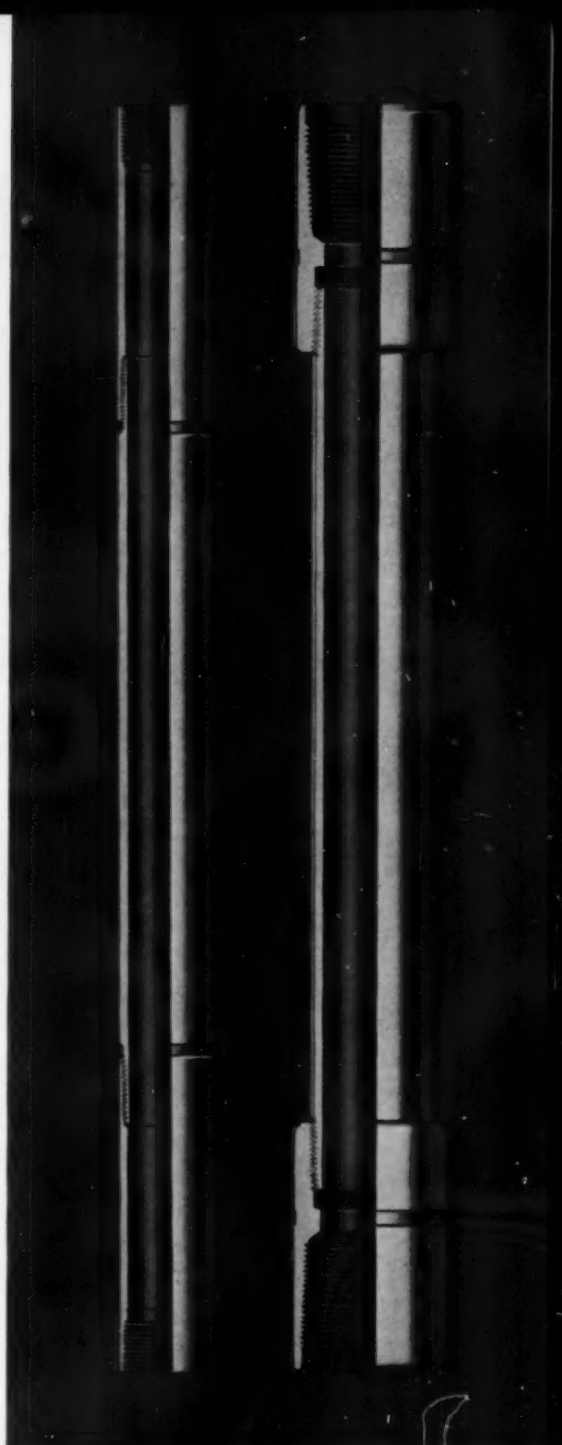

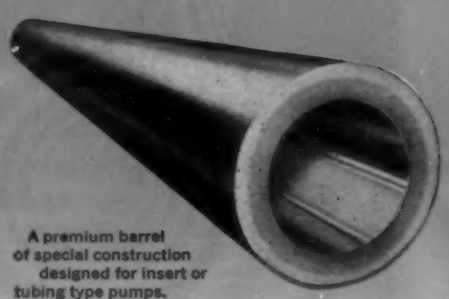

A premium barrel of special construction designed for insert or tubing type pumps.

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The generator is direct-connected to the engine for positive, permanent alignment. Of dripproof design, it is rated at 5,000 watts at 115 volts d.c. The total weight of the Model 5CCK-115P unit is only 315 lb. **Write or call: D. W. Onan & Sons, Inc., 2515 University Avenue S. E., Minneapolis 14, Minn., for details on Model 5CCK-115P plant.**

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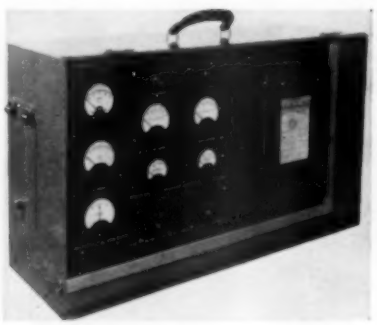
Pressure Tester Gives Accurate Calibration

Accurate pressure calibrations not ordinarily possible with oil dead-weight testers or mercury manometers may now be accomplished with this new CEC primary pressure standard. Operating as an air dead-weight tester, the instrument offers: (1) advantages of a frictionless pressure medium, (2) extreme accuracy even at pressures of less than 1 psi., and (3) portability regardless of the pressure range, company officials say.

The instrument, known as the Type 6-201 primary pressure standard, depends on mass and length measurements for its accuracy. It will calibrate any pressure-measuring device.

Pressure calibration is achieved by balancing controllable air pressure against the force generated by a weighted piston. When piston is lifted and held in a suspended position by air pressure, a given pressure has been established. This same pressure, fed simultaneously to the device under test, provides the means for calibration.

The basic unit houses a drive motor and an assembly on which one of a selection of piston-cylinder combinations can be mounted. The upper part of the unit is fitted with a glass cover. **Write or call: Consolidated Electrodynamics Corp., 300 North Sierra Madre Villa, Pasadena, Calif., for Bulletin 1581.**



Gas-Measuring Instrument Determines Explosive Limit

Now the Atlas Model 550 Chart-O-Gas measurement and recording instrument again is available. Gas emerging from the wellhead during drilling is recorded by the instrument. And the actual percentage of the lower explosive limit is measured and continuously recorded on a chart.

A classification instrument is part of the panel. It is used with a sensing unit to measure the methane or propane and butane series in cuttings and cores.

Though the detector elements are

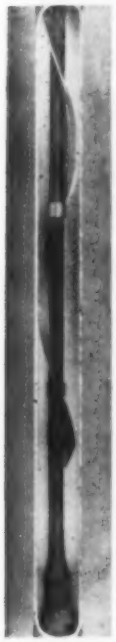
specifically calibrated for methane and ethane, they will react to any hydrocarbon found in the well. A hydrocarbon selector switch permits determination of the presence of methane or ethane and other higher-series hydrocarbons.

With this unit, no mud pump or air aspirator bulb is needed. A simple swage inserted between the welihead and the shale shaker is the only connection needed. The instrument can be located at some distance from the point where the sensing unit is inserted and connected by wires.

This instrument is ruggedly constructed. Its case is of spot-welded steel, having a durable enamel finish. A wooden case for automobile battery and a battery charger for either a.c. or d.c. power are included. An audible alarm, which sounds when a specific percentage of gas is met is available as an accessory. **Write or call: Atlas Laboratories, Inc., P. O. Box 6247, Houston 6, Tex., for details on Chart-O-Gas.**

●

Paraffin Scraper Uses Continuous Spiral



The makers of this new paraffin scraper for pumping oil wells say its effectiveness is greatly enhanced through the use of a continuous-spiral design. The new scraper features a single spiral wing, running the full length of the sucker rod.

The new design is said to cut running time by eliminating intermittently spaced wings which can bunch and hang on well tubing. Because its single leading edge is shielded by the sucker rod's joint shoulder, the scraper centers itself and feeds itself downhole.

The longer spiral (it circles the rod only once each 15 in.) offers less drag. This, say the makers, is a double advantage, because there is easier flow on less pump power and less tendency for paraffin scrapings to cling, resulting in a faster flow, carrying more paraffin.

In the center of the sucker rod, the direction of the spiral is reversed. This resists torque and eliminates the possibility of rod joints unscrewing.

The tough lightweight wing is fastened in place with steel clips pressed around the rod under high pressure, without any welding on the rod. Because it is a full-length scraper, the wing cannot slip under normal conditions. **Write or call: Sunshine Iron Works, 601 West Murphy, Odessa, Tex., for details on spiral paraffin scraper.**

●

Automatic Valve Works On Differential Pressure

This automatic shutoff valve is said to have three new basic design features which provide accurate control of the oil level in tanks and prevent air from entering the pipeline. A diaphragm-actuated balanced type, the valve operates on tank-pressure differential.

The valve has a cylinder with four parts mounted vertically. On the inside of the cylinder is a piston or sleeve which makes it seal above and below the ports with O-rings.

Oil flowing into the upper valve cavity acts against the diaphragm to lift the piston, clearing the ports. This action permits oil to flow through the piston, out of the ports, into the lower valve cavity, and then down stream.

The vertical piston is unaffected by back pressure. The upstream tank head

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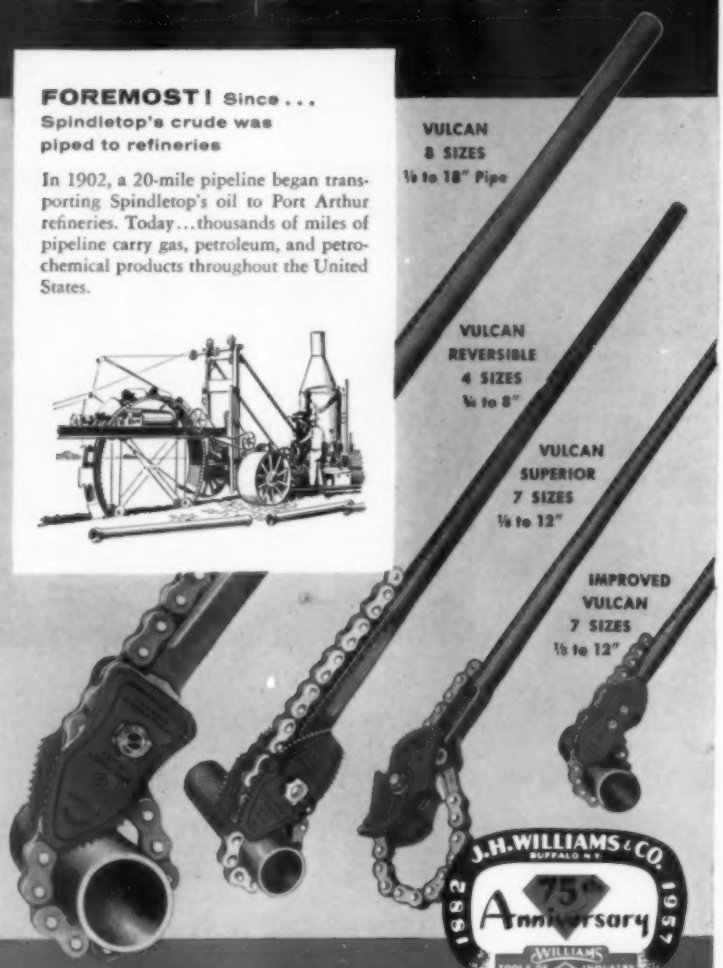
⅛ to 12"



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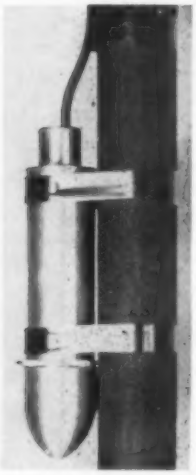
is the only factor that controls the opening and closing of the valve.

The spring-loaded rotating toggles hold the valve open for a period of time. As the liquid level in the tank drops, the toggles keep the valve open until the pressure reduces to a certain amount. Then they snap the valve closed. This feature prevents starvation of a pump that might be in the pipeline. **Write or call: W. L. Walker Co., 1009 South Main, Tulsa, Okla., for details on automatic shutoff valve.**

●



Fluid-Level-Actuated Switch Controls Pump Cycle

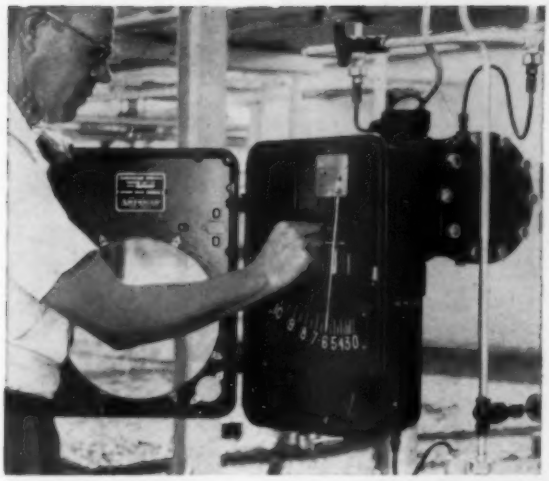
This new pressure-activated switch turns on and off electric-driven oil-well pumps as determined by the fluid level in the casing, replacing the time-clock method of cycling a well.

According to the maker, use of the pressure switch can result in production increases, as well as shortened pumping time, because the pump will operate when fluid is present and will not allow overpumping of a well. And maintenance costs and individual well supervision expenses may be reduced.

The pressure switch is located directly above the pump and attached to the production tubing. A two-conductor wire runs from the switch to the surface and connects to a conventional magnetic starter.

With the exception of very deep wells, no additional switches or transformers are necessary. A pilot light can be incorporated, indicating whether or not the pump should or should not be running.

Also, means are available to stop a conventional type of gas engine, should the fluid level reach a predetermined point. **Write or call: R. H. Hill & Associates, 2809 Broadway, Fort Wayne, Ind., for details on pressure switch.**



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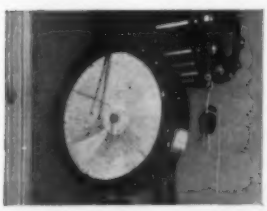
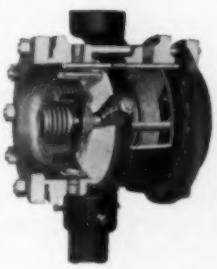
You can't match American® DRI-FLO Meters for versatility, accuracy and proven dependability.

Above, an American DRI-FLO Meter is used to measure ethane reflux flow on a de-ethanizer unit in a gasoline plant at 500 psi and 80 to 100° F, typical of one of the many installations meeting the most exacting requirements.

Below, a DRI-FLO manometer is shown measuring lease gas and is used in conjunction with a 30-year-old recording mechanism — proof of the versatility and long service life built into American products.





DRI-FLO Meters bring American-Westcott precision, simplicity of installation and maintenance, with maximum resistance to corrosive materials, to orifice meter measurement. Differential ranges: 20", 50", 100", and 200"; Working pressures 1000 and 5000 psi; Ambient temperatures of —25 to 175°F.

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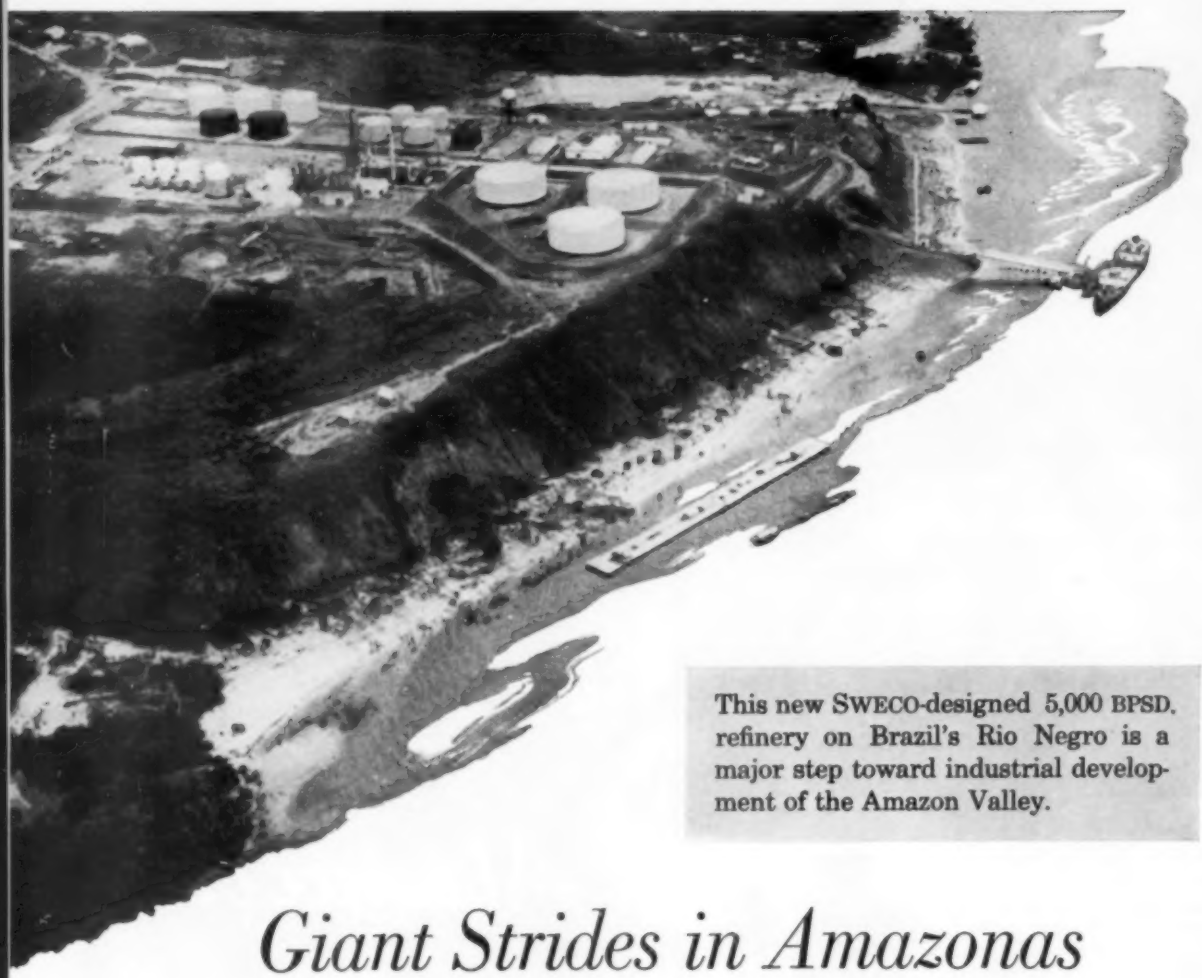


This new SWECO-designed 5,000 BPSD. refinery on Brazil's Rio Negro is a major step toward industrial development of the Amazon Valley.

Giant Strides in Amazonas

Three weeks by ship from New York and 1,000 miles inland from Belém lies Manaus, Brazil. Here, Companhia de Petroleo da Amazonas (COPAM) wanted to build a refinery to provide an immediate source of refined oil, vital to industrial development of the Amazon Valley's vast potential.

SWECO's Engineering and Construction Division designed tanker loading and unloading facilities; storage for crude and finished products; crude and vacuum, catalytic cracking, and gas concentration units; a steam plant; an electric generating plant.

Torrents of problems

No. 1 problem was distance and communications. Manaus is 2,500 air miles from the industrial centers of southern Brazil. Contact with SWECO's home office in Los Angeles was by wireless.

Construction equipment and materials had to be shipped from the States. For five or six months each year, torrential rains slowed down operations. Labor was another big problem. It was nearly impossible to recruit trained craftsmen from the south.

Procurement and inspection

SWECO engineers were responsible for procurement as well as design. They inspected all construction – including the refinery's catalytic cracking unit, which uses a process licensed by Universal Oil Products Company, one of the many licensors providing refining processes and technology to SWECO. All heat exchangers and columns were made at SWECO's Los Angeles plant and shipped to Manaus.

To SWECO engineers who design and build moderate-size refineries, chemical plants and ore beneficiating mills all over the globe, the COPAM refinery is a clear victory over impossible logistics and elements. Whether the job is in the distant interior of Brazil or here at home, SWECO delivers . . . on schedule.

That's the basis of SWECO's reputation for dependability and service... in *engineering and construction* of refineries, chemical plants and ore beneficiating mills . . . in the design and manufacture of *process equipment* such as heat exchangers, steam jet ejectors and distillation columns . . . and in a complete line of *vibrating screen separators.*

Write today for our new brochure on how SWECO products and services can help meet your processing needs. Ask for brochure E-3-317.

SWECO

Southwestern Engineering Company

Engineers and Constructors . . . Manufacturers

4800 Santa Fe Avenue • Los Angeles 58, California

New Literature

Slush Pump and Fluid End Parts Maintenance Manual. In its 24 pages this new pocket-sized illustrated booklet describes maintenance procedures that will prevent interruptions of operation and extend pump life. It briefly and clearly describes the care of each working part (piston rods, pistons, valves and seats, liners, and packing), assembly procedures, and proper pump operation. **Write or call: National Supply Co., Two Gateway Center, Pittsburgh 22, Pa., for slush-pump maintenance manual.**

•

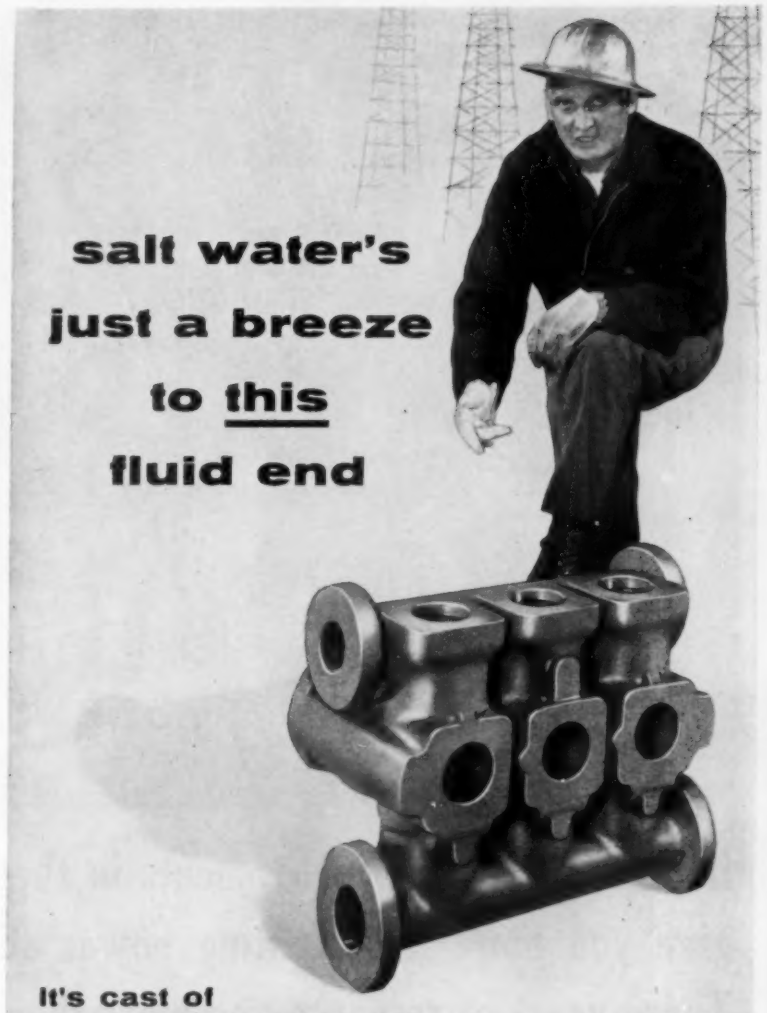
Protective Linings and Coatings. This new brochure discusses protective linings and coatings, why they are important, and when and how they should be applied. One section explains what porosity is, how it can be determined, and what to do about it. Suitability of a protective system to its environment is also discussed in detail. The brochure describes and evaluates sheet linings and organic, inorganic, metallic, and combination coatings. Presenting design problems and specification sheets, the brochure discusses preventive maintenance with details on how a program should be set up as well as the reasons for setting it up. **Write or call: Protective Coatings Div. of Metalweld, Inc., 3201 Scotts Lane, Philadelphia 29, Pa., for protective linings and coatings brochure.**

•

Control Valves. Specification Folders S810-11 and S810-12 (each four pages) give details of construction on single-seated and double-seated Honeywell Series 800 diaphragm - control valves. The folders include sizes, materials, plug-characteristic curves, dimensions, and a cross-section drawing of each type. These pneumatically operated valves are applicable for controlling the flow of liquids, gases, and steam under a wide range of operating conditions. **Write or call: Minneapolis-Honeywell Regulator Co., Valve Div., Wayne & Windrim Avenues, Philadelphia 23, Pa., for Specification Folders S810-11 and S810-12.**

•

Steel Fabricating Brochure. This 12-page 2-color booklet describes and illustrates equipment fabricated for chemical and petroleum - processing plants, heat exchangers, columns, and jacketed stainless-steel tanks for mis-



It's cast of
AMPCO METAL
for tough pumping conditions

Salt water won't damage this unusual aluminum-bronze alloy. It's specially engineered to guard against failure caused by corrosion, erosion, abrasion, and cavitation-pitting. It provides exceptional strength — and does it with less weight than ordinary bronzes.

Check for this protection, when you look at specifications of duplex and triplex pumps. And insist on fluid ends of Ampco Metal for replacements on your old pumps.

Send coupon for further information on Ampco Metal in corrosive applications.

AMPCO® THE METAL WITHOUT AN EQUAL

AMPCO METAL, INC., Dept. OGJ-5, Milwaukee 46, Wisconsin
West Coast Plant: Burbank, California

AMPCO METAL, INC.
Dept. OGJ-5,
Milwaukee 46, Wis.

Send me Bulletin PI-5a on Ampco Metal

P-30

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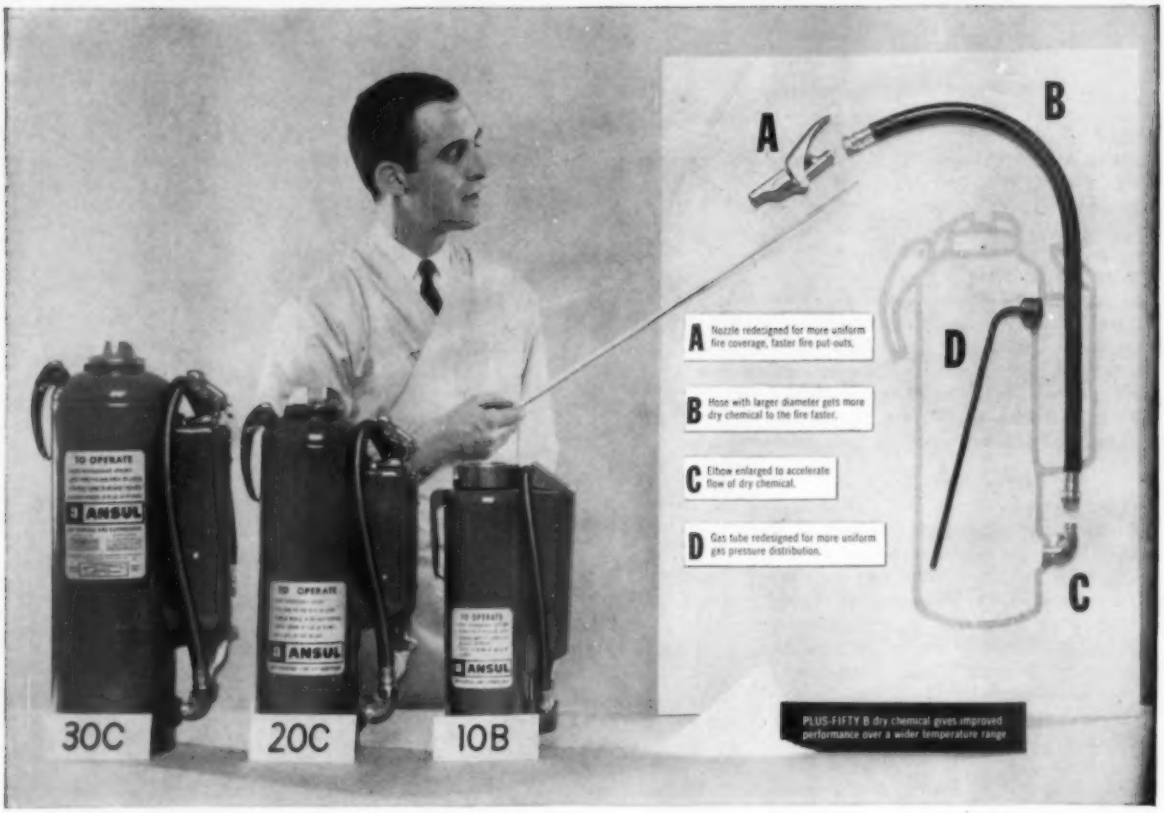
CITY..... ZONE..... STATE.....


A
B
C
D
A Nozzle redesigned for more uniform fire coverage, faster fire put-outs.
B Hose with larger diameter gets more dry chemical to the fire faster.
C Elbow enlarged to accelerate flow of dry chemical.
D Gas tube redesigned for more uniform gas pressure distribution.
PLUS-FIFTY B dry chemical gives improved performance over a wider temperature range
ANSUL
30C
20C
10B

Important design improvements in these Ansul Extinguishers give you more fire fighting power at no increase in price. Three years of research and more than 2000 fire tests turned up some significant new information on dry chemical extinguishment. Ansul engineers were able to design these findings into three new extinguisher models, the 10B, 20C and 30C. Result, greatly increased fire fighting power. All Ansul equipment is backed by a five-year warranty. This is the best way we know to say Ansul fire extinguishers are the finest of their kind made anywhere.

ANSUL

The Ansul Chemical Co., Marinette, Wisconsin

cellaneous uses. The brochure devotes several pages to a description of the maker's plants and facilities and steel-plate warehousing and specialized services. **Write or call: McGregor-Michigan Corp., 5890 Rivard Street, Detroit, Mich., for steel-fabricating brochure.**

•

Earth-Drilling Accessories. This handy catalog packet is devoted to a line of earth-drilling accessories including augers, core barrels, drilling heads and bits, winches, couplings and other equipment. Pockets on the inside front and back covers carry additional literature on mobile rotary-drilling rigs, as well as the story of the company's soil and foundation engineering service. **Write or call: Mobile Drilling, Inc., 960 North Pennsylvania Street, Indianapolis 4, Ind., for catalog on earth-drilling accessories.**

•

Rotary Mechanical Seals. New 16-page Catalog 480 presents descriptions and recommended uses of Durametallic rotary mechanical seals. The catalog is organized to make it easy to select the right type of mechanical seal to meet a specific operating condition. It is extensively illustrated with cutaway views showing stuffing-box installation details. Each seal is accompanied by a quick reference covering the temperatures, pressures, and fluids it is designed to serve. **Write or call: Durametallic Corp., 2104 Factory, Kalamazoo 24 F, Mich., for Catalog 480.**

•

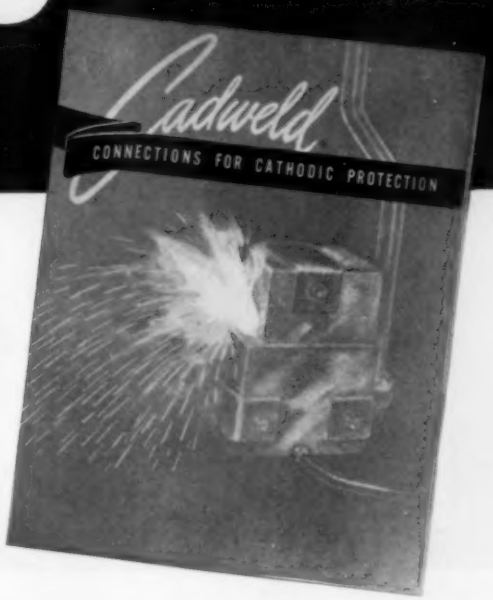
Wire Screen Cloth for a variety of strainer applications is described in this six-page folder. Available in a variety of special alloys and in aluminum, copper, brass, monel, and stainless steel, the wire cloth described is made in all commercial sizes in lengths of 100 ft. and in widths of 24 to 72 in. Illustrations and text detail the features of the more popular wire-cloth-weave styles. **Write or call: C. O. Jelliff Mfg. Corp., Southport, Conn., for folder on mesh products.**

•

How to Obtain Longer V-Belt Life is explained in new 12-page Bulletin 20X6234C. The bulletin gives simple precautions to take to prolong the life of V-belts and increase drive efficiency. Describing various types of V-belts, it tells how to select and match them. Also, it lists seven steps for the correct installation of belts and offers many hints for making them last longer. The bulletin illustrates eight of the most

CATHODIC PROTECTION DEMANDS

100% EFFICIENT ELECTRICAL CONNECTIONS



CATALOG ON REQUEST

CADWELD eliminates loose or corroded electrical connections in your CATHODIC PROTECTION SYSTEM.

That is the basic reason for specifying **CADWELD** . . . the connection that fuses the conductors into a solid homogeneous mass. The connection is then a part of the conductors.

There is nothing to loosen.
There is nothing to corrode.

Figure the total cost of the equipment being protected, plus the cost of the Cathodic Protection System. You'll want the best ELECTRICAL CONNECTIONS available . . . **CADWELD.**

Erico Products Inc.

2070 E. 61st Place

Cleveland 3, Ohio

IN CANADA: ERICO INCORPORATED, 2571 Dundas St., West, Toronto 9, Ontario

ERICO PRODUCTS, INC., 2070 EAST 61st PLACE, CLEVELAND 3, OHIO

1. Send Bulletin 656-10 . . . . . ☐
2. Send name of local Dealer . . . . . ☐

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MATCHLESS STEAM HOSE

"U. S. Matchless #5 does 5 different jobs,"

says refinery division superintendent

"It always passes our strictest lab tests."

A mechanical division superintendent of a leading Midwestern refinery says:

"U.S. Matchless Steam Hose always passes our central maintenance department tests, and we've always had good experience with it. The neoprene cover is oil-resistant. The hose is highly flexible and light in weight. Asbestos ply, under the cover, conserves heat. Wire braid preserves static ground."

This great "U.S." hose is serving many industries in many ways. It is obtainable at selected "U.S." distributors, at any of the 28 "U.S." District Sales Offices, or write us at Rockefeller Center, New York 20, N. Y.

Uses in refinery for U.S. Matchless® #5 Hose:

- As a firefighting hose, for safety-checking atop the 235-ft. cracking unit (see picture above).
- In propane tank, to thaw bottom of gauge glass in cold weather (see inset picture above).
- In pump room of cracking unit, as a steaming line to get gas traces out of the unit.
- On propane transfer line, to prevent orifice from freezing in cold weather.
- Enables construction crews to run temporary steam lines more cheaply and quickly than using pipe.

Mechanical Goods Division

United States Rubber

common causes of V-belt destruction, including snub break, slip burn, base cracking, abrasion, oil deterioration, rupture, ply separation, and worn sides. **Write or call: Allis-Chalmers Mfg. Co., Milwaukee 1, Wis., for Bulletin 20X6234C.**

•

Side-Boom Tractors for pipe laying with lifting capacities ranging from 17,000 to 110,000 lb. and their applications are the subject of this new eight-page folder. On-the-job photos and captions show and describe the units in actual use. Diagrams illustrate valuable attachments available for the tractors. **Write or call: International Harvester Export Co., 180 North Michigan Avenue, Chicago 1, Ill., for Folder E-29-G.**

•

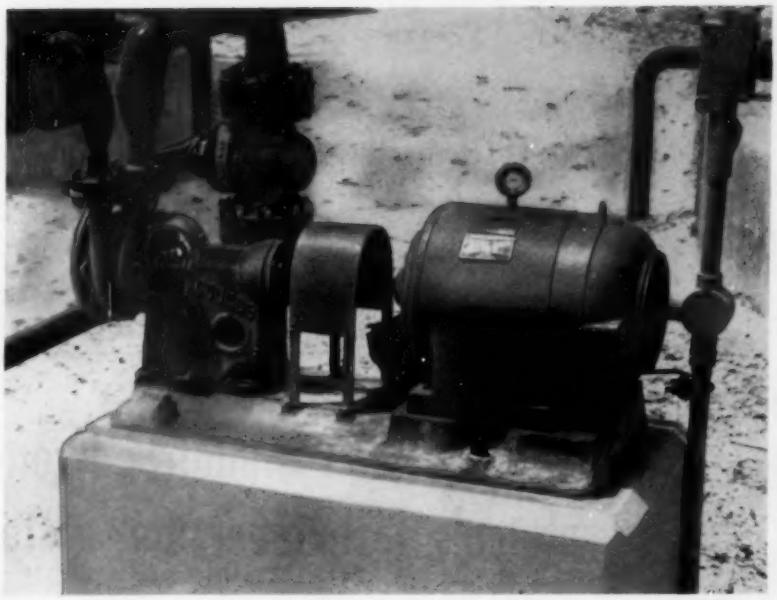
Indicating Pneumatic Controllers. Catalog C600/700 1 describes Brown small-case indicating pneumatic controllers for temperature and pressure, with temperature ranges between 0° to 1,000° F. and pressure ranges from 0 to 1,000 psi. The eight-page catalog contains specifications, schematic diagrams, and photographs of the controllers. It also gives instructions on how to order them. **Write or call: Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne and Windrim Avenues, Philadelphia 44, Pa., for Catalog C600/700 1.**

•

Belt Type Gravimetric Dry Material Feeder (Model 37-20) designed for continuous high-capacity feeding is the subject of new two-color, four-page Bulletin 35-N62. Informative sections describe the advantages, principles of operation, and features of a mechanical controller. Giving dimensional and performance specifications, the bulletin is profusely illustrated with cutaway views, halftone illustrations, and typical installation photographs. **Write or call: Omega Machine Co., 345 Harris Avenue, Providence, R. I., for Bulletin 35-N62.**

•

How to Select Self-Adhesive Pipe-Marking Materials is the theme of this new eight-page catalog. The catalog lists over 500 self-adhesive vinyl-plastic pipe markers which conform to accepted standards. It illustrates self-adhesive cutout numbers and letters and stock safety slogans. The catalog also discusses many other self-adhesive products for use by plant maintenance and safety engineers. **Write or call: Printed Cellophane Tape Co., 521 North La Brea, Los Angeles 36, Calif., for pipe-marking materials catalog.**



THIS OLD-TIMER *laughs* AT SALT WATER DAMAGE

It's a Goulds chemical pump

Its fluid end was built to handle salt water . . . has been handling that corrosive stuff for a long time.

That fine old pump (a Fig. 3705) has been redesigned. Now, as Fig. 3715, it's even better.

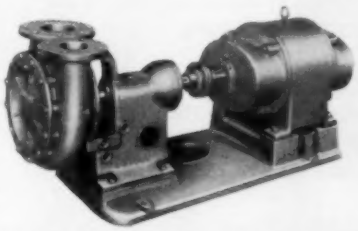
Designed to resist corrosion

This pump is available in a variety of materials: Type 316 and Gould-A-Loy 20 stainless steel, all aluminum-bronze, all iron or bronze fitted. Each of these materials offers specific resistance to corrosion, abrasion, pitting, and other pump hazards. All you have to do is match the metal to your pumping problem. (For example, a fluid end in aluminum-bronze is best for salt water duty.)

All-around economy

Properly specified, these pumps give long service under severe conditions. Because many parts are interchangeable, you can standardize on Fig. 3715 for a variety of liquids, and need only a low spare parts inventory.

For complete information on these remarkably durable pumps, ask for Bulletin 725.4.



Goulds Fig. 3715—Nine sizes: capacities to 720 GPM, with heads up to 200 ft.

GOULDS

PUMPS FOR INDUSTRY

GOULDS PUMPS, INC.
Seneca Falls, N. Y., Main Office and Works
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PHILADELPHIA, 2099 North 63rd St.
PITTSBURGH, Room 512 Bessemer Bldg., 140 - 6th St.
TULSA, 543 East Apache St., P. O. Box 6157

West Coast Representative: GOULDS PUMPS Western, Inc., 1919 N.W. Thurman St., Portland 9, Oregon
In Canada: The A. R. Williams Machinery Co., Ltd. . . . in all principal cities

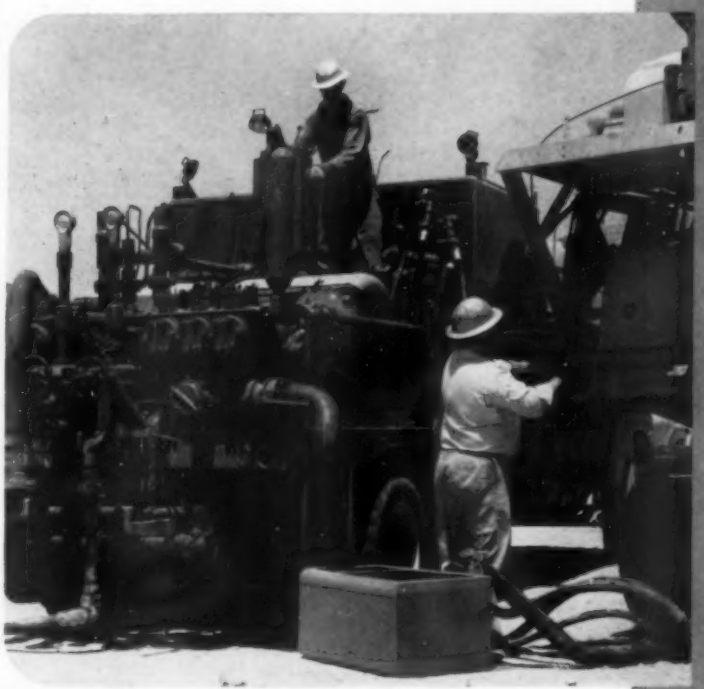
Treat and squeeze effectively...

with Halliburton's unmatched combination of tools, techniques and materials

Halliburton offers a complete line of packers and auxiliary tools for remedial squeeze cementing, hydraulic fracturing, acidizing and chemical services wherever it is necessary or desirable to confine applied hydraulic pressure to subsurface formations.

These tools, combined with Halliburton's big world wide service fleet and oil field know how, give you the ultimate in desired results.

Call your local office or write the Halliburton Oil Well Cementing Company, Duncan, Oklahoma.



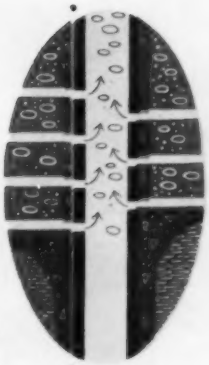
HALLIBURTON

OIL WELL CEMENTING COMPANY

"Water Hunter"

HALLIBURTON'S DOC

(DIESEL OIL CEMENT)



This versatile product uses the water in the formation to produce a set cement of high density, high compressive strength and very low permeability.

Since DOC is composed only of cement, diesel oil and Halliburton's efficient dispersant DOC-1, it will never set hard until contacted by water.

Initial contact of DOC with water thickens the slurry. This desirable feature provides effective water shut-off with relatively small volume of this low fluid loss mixture.

RTTS (RETRIEVABLE TEST-TREAT-SQUEEZE) PACKER

HYDRAULIC RETRIEVABLE PACKER

"DM"—"DC" SQUEEZE PACKER

The right type of packer improves the job

RTTS PACKER (Retrievable Test-Treat-Squeeze)

This multiple purpose packer permits combination high pressure treating and squeezing applications with one trip into the well... features full opening fluid passage... incorporates circulating valve, safety joint and drillability for squeeze cementing.

HYDRAULIC RETRIEVABLE CEMENTER

Simply operated, set easily by hydraulic pressure, with automatic pressure testing of tubing as packer is set, the HRC is designed to perform efficiently under the highest pressures and most difficult operating conditions encountered in squeeze cementing.

"DM"—"DC" SQUEEZE PACKERS and Bridge Plugs

Designed for squeezing and bridging operations under all present depth and pressure conditions. These economical, dependable tools are easily set on tubing or electrical wire line for positive fluid shutoff.

HALLIBURTON

SPECIAL TOOL SERVICES

251 SERVICE CENTERS—JUST MINUTES AWAY FROM ANY RIG

EQUIPMENT MEN . . . in the News

American Chemical Paint Elects G. H. Williamson

George H. Williamson has been elected vice president in charge of West Coast activities of American Chemical Paint Co., Ambler, Pa. His new responsibilities will include supervision of all American Chemical Paint Co. activities, sales and service of metalworking and agricultural chemicals and processes, and manufacturing at the ACP plant at Niles, Calif.

Williamson has been with the company since 1935, specializing in the sales of rustproofing chemicals and processes for the metalworking field. In 1952 he was transferred from the Detroit branch to the new plant at Niles.

George Engine Buys Cessna To Speed Sales, Service

George Engine Co., Inc., Harvey, La., has recently acquired a Model 180 Cessna seaplane, according to Herb Colby, sales manager. Piloting the new plane is Charlie Lopez, who joined the firm just prior to delivery of the plane. In addition to his duties as pilot, Lopez is also sales engineer for GEC. He will cover by air George Engine Co.'s various drilling locations and shipyards in the Gulf States area. The company has built a new ramp and hangar to enable the plane to land on the Intracoastal Canal and taxi in back of the main offices and shops.

Lopez has had experience in the oil industry in Louisiana. He piloted for Magnet Cove Barium and served as a sales and service engineer. He also worked for Continental Oil Co. as a petroleum engineer and drilling foreman.

Halliburton Employes Attend Chemical Services School

As part of its expanding operation and continuous training, selected field employes go to Duncan, Okla., headquarters of Halliburton Oil Well Cementing Co., for on-the-job training in the chemical services school.

Here inspecting one of the giant T-10 pumps used on Halliburton's mobile units are: Frank Young, fieldman, Sundre, Alta., Canada; I. W. McNair, cementer, Lovington, N. M.; Raymond Hill, fieldman, Rule, Tex.; F. J. Swisher, Jr., driver, Houston; and Bill Sorenson, cementer, Anson, Tex.

Knight-Gordon Named Reliance Sales Agent

Knight - Gordon Engineering, Tulsa, is now petroleum-industry sales agent in Oklahoma and Kansas for Reliance Electric & Engineering Co., Cleveland, Ohio.

Partners Arthur H. Knight and Milton J. Gordon of Knight-Gordon Engineering have extensive experience in the sales and engineering of oil-field specialty equipment in the Mid-Continent area.

McCullough Names Service Manager, Sales Engineer

The appointment of Clyde M. Saucerman as service manager of the Los Angeles branch of McCullough Tool Co. and naming of Don Prehoda as sales engineer in the Los Angeles Basin have been announced by I. J. McCullough, president.

Saucerman joined McCullough Tool in 1945 as junior operating engineer, later served as senior operating engineer, assistant district service manager and assistant export manager.

Prehoda joined the firm's service department in 1949 and prior to his recent appointment served as assistant branch service manager in the Los Angeles office.

McGinnis and Whetstone Are Promoted by BS&B

The promotion of William M. McGinnis to Gulf Coast regional sales manager and Walter Whetstone to central regional sales manager has been announced by C. A. Siver, vice president and general manager of the controls

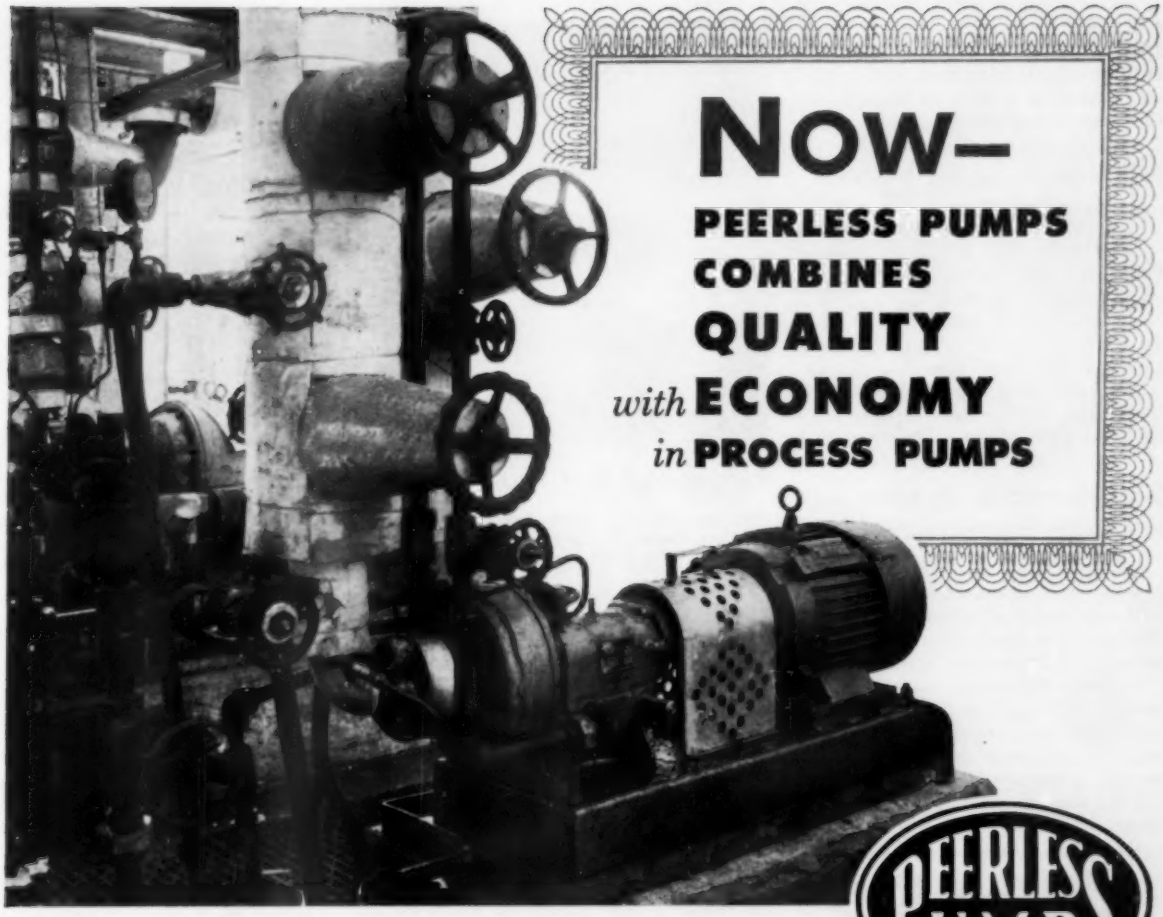
W. M. McGINNIS

W. WHETSTONE

division of Black, Sivalls & Bryson, Inc., Tulsa.

McGinnis, who has been with the controls division and predecessor companies for 13 years, served as sales and service engineer at Houston for 8 years, was promoted to Houston district manager in 1952, and moved to Tulsa in 1956 as coordinator of national accounts. As Gulf Coast regional manager he will supervise the activities of seven controls division sales offices. He will continue as coordinator of national accounts.

Whetstone, who has been manager

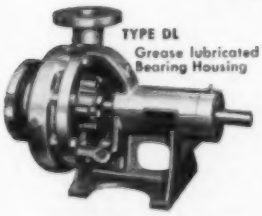


NOW—

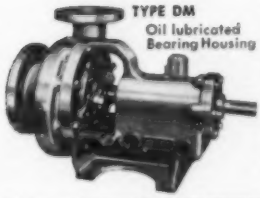
PEERLESS PUMPS COMBINES QUALITY *with* ECONOMY *in* PROCESS PUMPS

PEERLESS PUMPS

PUT THE IDEA OF PUMP COMPONENT INTERCHANGEABILITY TO WORK FOR YOU FOR SAVINGS IN FIRST COST— IN OPERATION—AND IN MAINTENANCE



TYPE DL
Grease lubricated Bearing Housing



TYPE DM
Oil lubricated Bearing Housing

Here's how component interchangeability works: Shown at the left are two types of Peerless chemical process pumps. The Type DL has a *grease* lubricated bearing housing; the Type DM has an *oil* lubricated bearing housing. To *either* of these bearing housings, you simply add the required backplate, impeller and volute. You "build up" the pump you want with either a water or air cooled backplate or an open or enclosed impeller.

In this way you match the temperature, pressure and other characteristics of the liquid being pumped. You "tailor make" the pump you want by complete component interchangeability—the Peerless idea—the modern idea in process pump buying.

Result: You stock up to 85% less parts; you reduce your capital investment; you obtain maximum versatility in pump application; you always pump with the most efficient pump for the intended service.

Write for NEW 12 PAGE BULLETIN, which completely describes and illustrates the Type DL-DM pump line, including specifications, dimensional data and performance charts. Use the coupon.

PEERLESS PUMP DIVISION
FOOD MACHINERY AND CHEMICAL CORPORATION
301 WEST AVENUE 26, LOS ANGELES 31, CALIFORNIA

PEERLESS PUMPS fmc

Factories: Los Angeles 31, California and Indianapolis 8, Indiana
Offices: New York; Atlanta; Chicago; St. Louis; Phoenix; San Francisco; Fresno; Los Angeles; Plainview and Lubbock, Texas; Albuquerque.
Distributors in Principal Cities.
Consult your Telephone Directory.

☐ *Please send me Peerless Pump Bulletin No. B-1608*

NAME_____ COMPANY_____

ADDRESS_____ CITY_____ STATE_____

OGJ

of BS&B's Wayne, Pa. (Philadelphia), office since 1951, will supervise the activities of 10 manufacturers' representatives from Atlanta to Detroit and St. Louis to Richmond.

Materials Handling Named Link-Belt Distributor

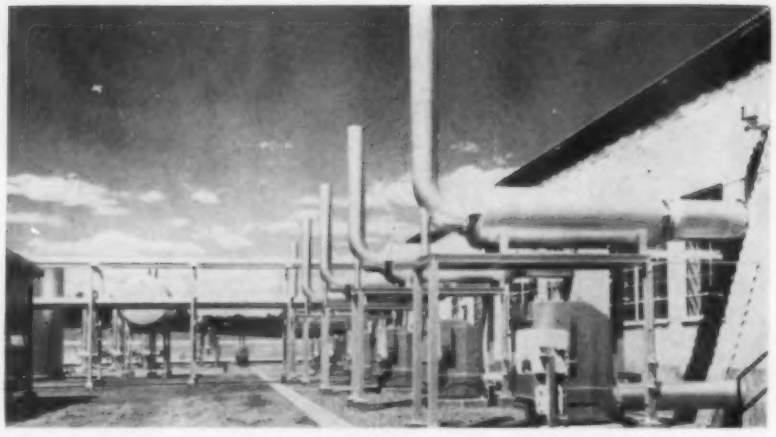
The appointment of Materials Handling, Ltd., Tulsa, as stock-carrying distributor for Link-Belt Co.'s power transmission and conveyor products has been announced by E. G. Wendell, Link-Belt district manager.

Materials Handling, Ltd., has offered sales and services in the material-handling field for many years.

Gay Named to Spencer Industrial Chemicals Post

Sidney N. Gay has been promoted to general sales manager of the industrial chemicals division of Spencer Chemical Co. Previously, he was sales manager of commercial products.

In his new capacity, Guy is responsible for the sales activities of industrial ammonia, methanol, formaldehyde, 83 per cent solution, aqua ammonia, commercial grade ammonium nitrate, dry ice, and liquid carbon dioxide.



Burgess-Manning Furnishes Snubbers for Gas Line

New type, low pressure-drop Burgess-Manning exhaust snubbers, shown here installed on six Clark Model TLA gas engine compressors at Durango, Colo., are very effective in silencing the exhaust noises.

The thirteen stations of the Pacific Northwest Pipe Line running from New Mexico to Washington, like this one at Durango, Colo., are equipped with these new turbosupercharged-type engine compressors. Each is equipped with low pressure-drop exhaust snubbers developed by Burgess - Manning Co. for this service and used exclusively for silencing all engines powering this pipeline.

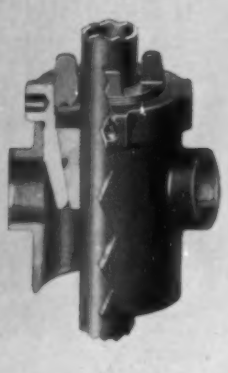
Smith Names Persson to Pressure Vessel Sales Post

A. C. Persson recently was named north central district sales manager of pressure vessels and heat exchangers for A. O. Smith Corp. Persson, a former sales engineer for the company's process equipment division, will continue to make his headquarters in Chicago.

HEAD OF THEIR CLASS

FIG. 91

Simplicity and compactness, for ease of installation and neatness of hookup, are incorporated into the Larkin Casing Head (2000 psi test, 1000 psi working pressure.) It is designed to provide a safe and economical means of suspending and packing off casing strings. This head has been tested to support 225,000 lbs., equivalent to 5600' of 7", 20-lb. casing with a safety factor of 2.



TYPE L

A new member of the Larkin Well Head line, the Type L Tubing Head fills a need in low pressure areas where economy may be effected with complete safety. It is forged steel construction, full opening, 2000 lb. psi, top of body threaded 7" API to accommodate control equipment, hinged three-segment slips, 2" or 3" side outlets.

For detailed information on these and other Larkin Tubing and Casing Heads, please refer to your Larkin Catalog or talk to your Larkin Representative. All Larkin Equipment is available through your supply store.

LARKIN LEADERSHIP HAS BEEN EARNED

W-K-M Appoints Tableman To Special Projects Post

Glen A. Tableman has been appointed assistant to the vice president, marketing, of W-K-M, division of ACF Industries, Inc., B. J. Gross, vice president, marketing, has announced.

Tableman will be in charge of special projects for the marketing division of the company. He joined W-K-M in 1949 as a service man, was promoted to sales and service representative, and in 1951 was made district sales manager of the Dallas-Fort Worth area.

Walker Well Heads Names Hoff as Chief Engineer

E. G. HOFF

The appointment of Earl G. Hoff as chief engineer has been announced by D. C. (Clint) Walker, president of Walker Well Heads, Inc., Tulsa.

Hoff was employed by Hinderliter Tool Co. where he had considerable experience in the design and manufacture of oil-field equipment. In 1952 he joined The Texas Co. as a petroleum engineer and was assigned successively to the Healdton, Drumright, and Tulsa area offices.

Otis Transfers Russell to Odessa as Division Manager

JACK RUSSELL

Jack Russell has been appointed manager of Otis Pressure Control, Inc.'s, division office in Odessa. He was formerly stationed in Odessa as a sales engineer and was transferred to New Orleans less than a year ago to represent the firm in the South Louisiana area.

Russell replaces Bill Mitchell who has been transferred to the company's New Iberia, La., division as district superintendent. Otis has had a branch facility in Odessa since 1948 and erected a new office and warehouse 2 years ago.

Russell started with the company as office manager in the Oklahoma City division. He was later transferred to the Corpus Christi division and to Hobbs, N. M.

National Geophysical Elects Vice Presidents

The election of W. J. Harkey and Harry L. Johnson as vice presidents of National Geophysical Co., Inc., has been announced by W. R. Mitchell,

W. J. HARKEY

H. L. JOHNSON

executive vice president of this Dallas-based geophysical exploration company.

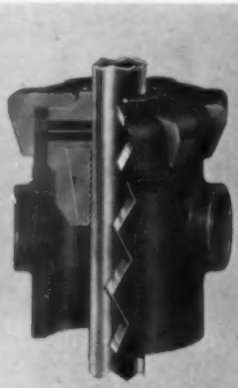
Johnson, who is in charge of National's Houston office, supervises Texas, Louisiana and other Gulf Coast activities. Harkey is located in Dallas where National maintains its headquarters.

Since joining National in 1937, Johnson has worked in all phases of geophysical work in the United States and Cuba and has served in a supervisory capacity with the company for the past 5 years. Harkey joined Na-

for medium pressure wells

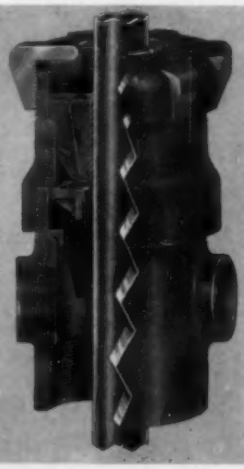
TYPE R

The Larkin Type R. Tubing Head is a conversion from the Type SR Head. This ease of conversion makes it possible to use the same stripper adapter and Neoprene stripper when working on any well equipped with a Larkin Tubing Head.



TYPE SR

The Larkin Type SR Tubing Head is a slip suspension head, equipped with a Neoprene Stripper which serves as a blow-out preventer and oil saver while tubing is being pulled or run. It is very suitable where higher pressures might be encountered.



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WAXAHACHIE, TEXAS

LARKIN

...Through Your Supply Store

BY YEARS OF DEPENDABLE PERFORMANCE

it takes men of vision
to build a better plant
Building is a business of men. Men with vision, with knowledge, with broad experience. Here at Procon we've concentrated on getting and keeping the best of them.
For years, the world over, Procon men have been planning and building refineries, petrochemical and chemical plants . . . to specifications and on schedule, time and again surpassing any reasonable goal.
We're proud of our men at Procon. To us they are truly those men of vision who do build better plants. Together they provide a complete design, engineering and construction service.
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WORLD-WIDE CONSTRUCTION FOR THE PETROLEUM, PETROCHEMICAL, AND CHEMICAL INDUSTRIES
PROCON

tional in 1937 and since that time has worked in all phases of geophysical exploration both in this country and Cuba.

Sperry-Sun Names Four Corners Representative

Ed Paulicek has been appointed to district representative in charge of the Sperry-Sun Well Servicing Co.'s new Four Corners area district office in Durango, Colo., to provide services for the Farmington, N. M., area.

Formerly a salesman in the company's Oklahoma City office, Paulicek has been with Sperry-Sun for 3½ years and has worked in Oklahoma and Kansas for the last 6 months. Prior to that he was a gyroscopic and multishot surveyor, working out of the Lafayette, La., office.

Mission and Rives, Dyke Earn ABP Award of Merit

Mission Manufacturing Co. and its advertising agency, Rives, Dyke & Co., both of Houston, have received recognition for business-paper advertising through an award of merit presented recently at the climax of Associated Business Publications' twelfth annual advertising competition. The award was accepted by Jack Faris, New York, Mission's export manager.

The achievement was in Division 2, the category including the advertising of maintenance and service equipment, parts and materials. Mission Manufacturing and Rives, Dyke also won the award in 1953.

The Associated Business Publication's award of merit and the advertising which won the award are discussed by principals of Mission Manufacturing Co. and Rives, Dyke & Co. Left to right are Wayne Rives, partner in the advertising agency; Richard White, Mission's executive vice president and general manager; and T. R. Fullinwider, Mission's domestic oil-field sales manager.

Twin Disc Makes Tulsa And Dallas Appointments

Loy F. (Si) Seamster has been appointed district representative in charge of Twin Disc Clutch Co.'s Tulsa branch office; H. B. (Bob) Hougan has been

L. F. SEAMSTER

LEE HANSEN

named district service representative at Tulsa; and Lee Hansen has been promoted to district representative at Twin Disc's Dallas branch office. These appointments were announced by N. F. Adamson, vice president, sales.

Seamster joined Twin Disc in 1956 as a sales engineer. Hougan has been with the company since 1944 and has been district service representative handling West Coast service problems for the past 5 years. Hansen joined Twin Disc in 1952 and was assigned to the Tulsa branch office. In 1953 he was transferred to the central service department at Racine, Wis.

J&L Supply Completes Expansion of Harvey Store

The expansion and remodeling of Jones & Laughlin Supply Division's oil-field supply store at Harvey, La., has been recently completed according to Rainey Elliott, president of the firm headquartered in Tulsa.

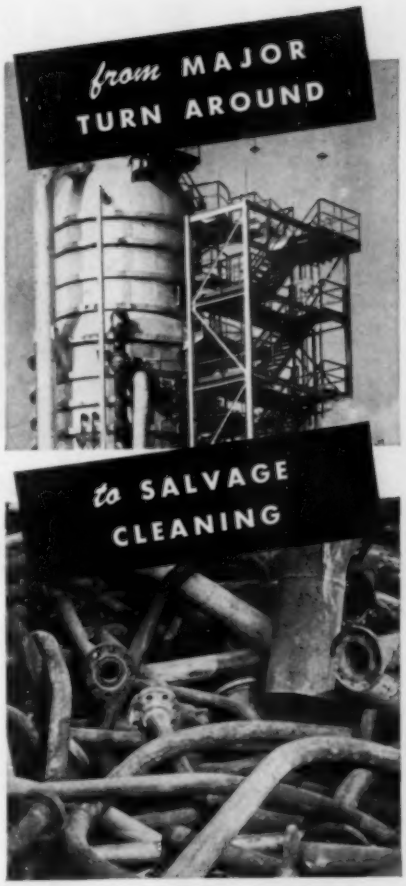
The warehouse space has been more than doubled and an additional 30-ft. inside dock with several sections of steel shelving has been incorporated into the building.

Operation of the Harvey store is under the over-all supervision of C. E. Rogers, district sales manager of J&L's Louisiana Gulf Coast district. R. E. Haulk is local store manager.

Axelson Appoints Factory Representatives for Texas

R. D. Whitehead and G. B. Seay have been appointed factory representatives for the petroleum division of Axelson Manufacturing Co. K. S. Ramey, Axelson petroleum sales manager, announced that both Whitehead and Seay will be assigned territories in the Texas area.

Whitehead will be headquartered at



Oakite speeds results . . . cuts costs

In a refinery at turn-around time, the Oakite man recommended in-place cleaning procedures and materials that gave virtually 95% perfect results—cut costly tower down-time 25%.

With Oakite materials removing rust, soil and paint from salvageable pipe, fittings, valves and other parts, one refinery estimates savings in excess of $50,000 a year.

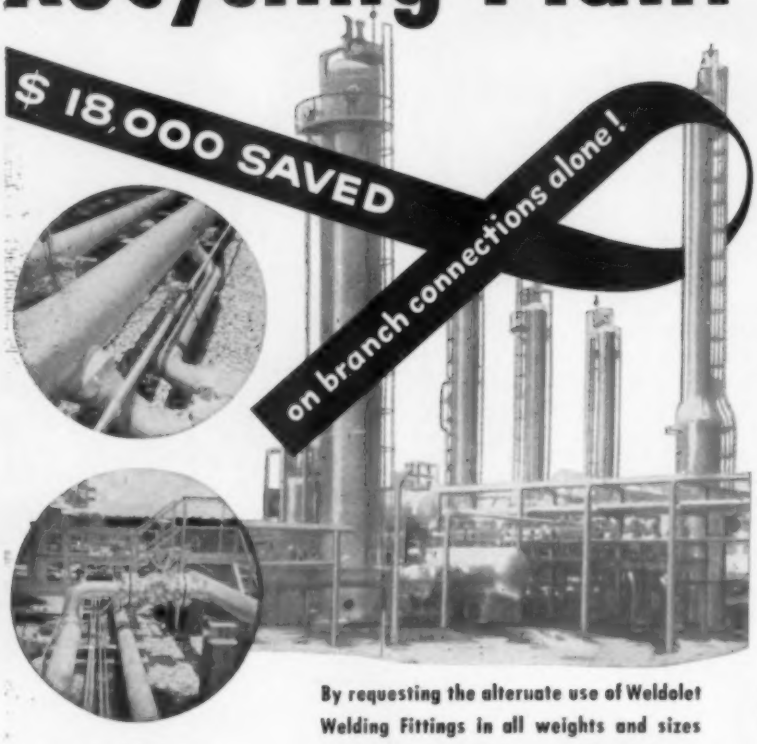
Just two jobs of the *many* where Oakite can help. Bulletin F-7629 tells more. Write Oakite Products, Inc., 39 Rector Street, New York 6, N. Y.

OAKITE

Export Division Cable Address: Oakite

Technical Service Representatives in Principal Cities of U. S. and Canada

4500 psi Recycling Plant



By requesting the alternate use of Weldolet Welding Fittings in all weights and sizes the piping contractor was able to lower his bid sufficiently to be awarded the job!

This recently completed recycling plant in Louisiana was designed and engineered in full accordance with the ASA and ASME Codes and operates at a maximum pressure of 4500 psi and 225°.

The piping engineers on this job were confronted with a number of tough problems. The plant was to be operated at extremely high pressures. The terrain was swampy which meant the fittings had to withstand the additional stresses exerted by a settling foundation. The piping also had to stand up under rugged vibration conditions. The many design features of Weldolet Welding Fittings in both full size and reducing size outlets provided the safe, practical and most economical answer to these knotty service problems.

PENNSYLVANIA DIVISION

BONNEY FORGE & TOOL WORKS

Dept. H

ALLENTOWN, PENNA.

Levelland and cover the Sundown area. Seay will be headquartered at Luling and will cover the Luling, Pleasanton, and Victoria territory.

Maintenance Engineering Opens Shreveport Office

D. R. CARROLL

To give better service to customers in the Arkansas, Louisiana and East Texas areas, Maintenance Engineering Corp., Houston, has opened a new sales office at Shreveport, La., with Dave R. Carroll as manager. The announcement was made by C. E. Naylor, chairman of the board of directors of Maintenance Engineering.

Carroll joined Meco in 1953 and became sales and service engineer. His previous experience was with Humble Pipe Line Co. as corrosion engineer and with a core-analysis firm.

Pickard and Price Elected To New Posts by Tuboscope

The elections of B. H. Pickard as president of Tuboscope Co. and B. G. Price as vice president of engineering

B. H. PICKARD

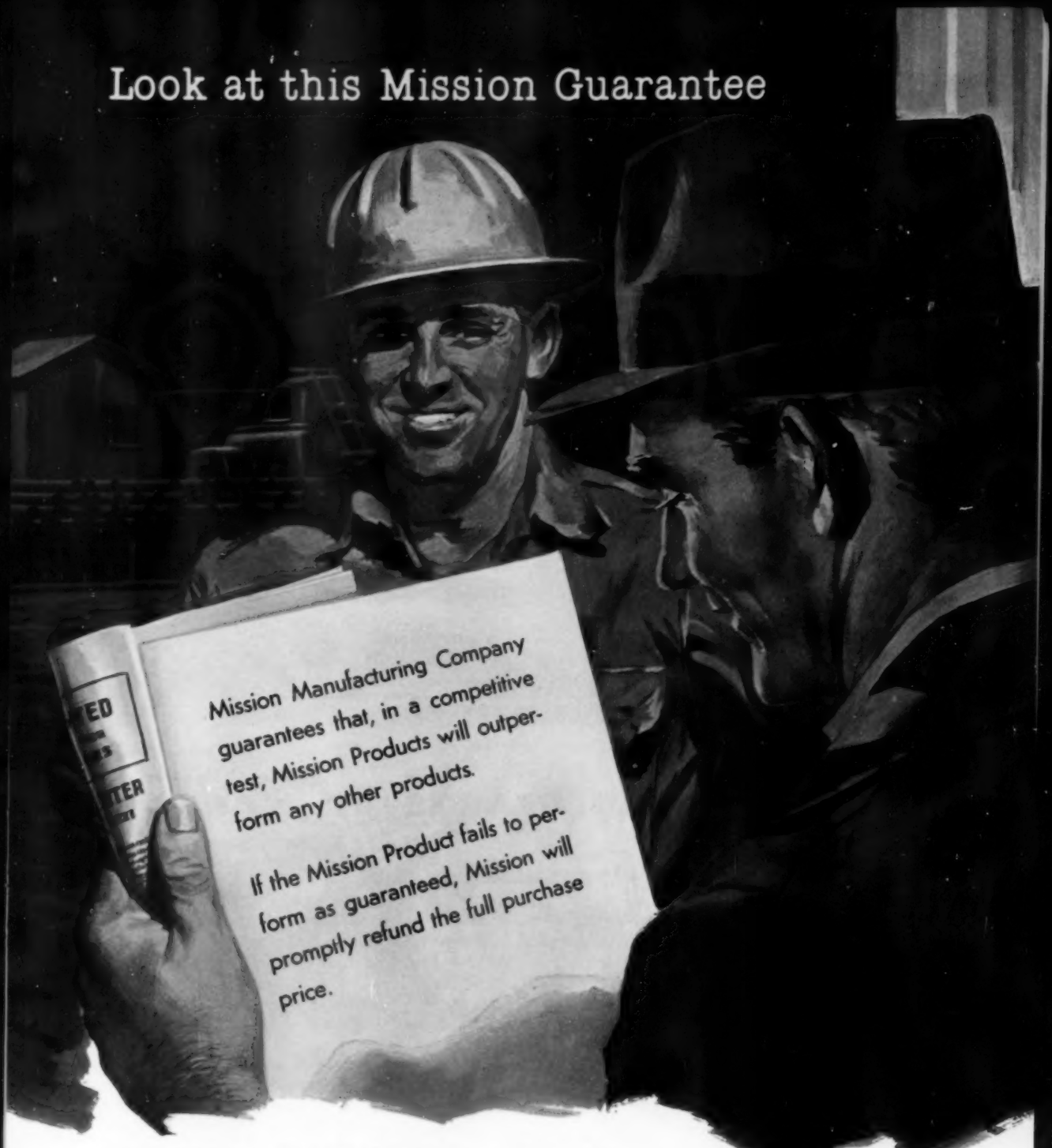
B. G. PRICE

research and development and assistant general manager have been announced.

Pickard has been general manager of Tuboscope for the past year. He joined the company in 1941 as a trainee and served in operational jobs in Odessa before being named operator in charge in Houston in 1943. He was made district manager in 1947, division manager in 1948, Texas Gulf Coast manager in 1951, was elected vice president in 1952, manager of sales in 1954 and assistant general manager in 1955.

Price joined Tuboscope in 1938 as a trainee and served in various capacities in Houston and Illinois before being named district manager in Kansas. He also was district manager in Oklahoma from 1942 to 1944, Tuboscope representative in Mexico for a year and served in that capacity in

Look at this Mission Guarantee


Mission Manufacturing Company guarantees that, in a competitive test, Mission Products will outperform any other products.
If the Mission Product fails to perform as guaranteed, Mission will promptly refund the full purchase price.

If you are not now using Mission Products, or if you have any reason to doubt their superiority, make a competitive test. Prove to yourself how much Mission Products can save you. Your Mission Representative will gladly help you select the correct Mission Products for your conditions. Call him!

Nothing but the finest will bear the name of

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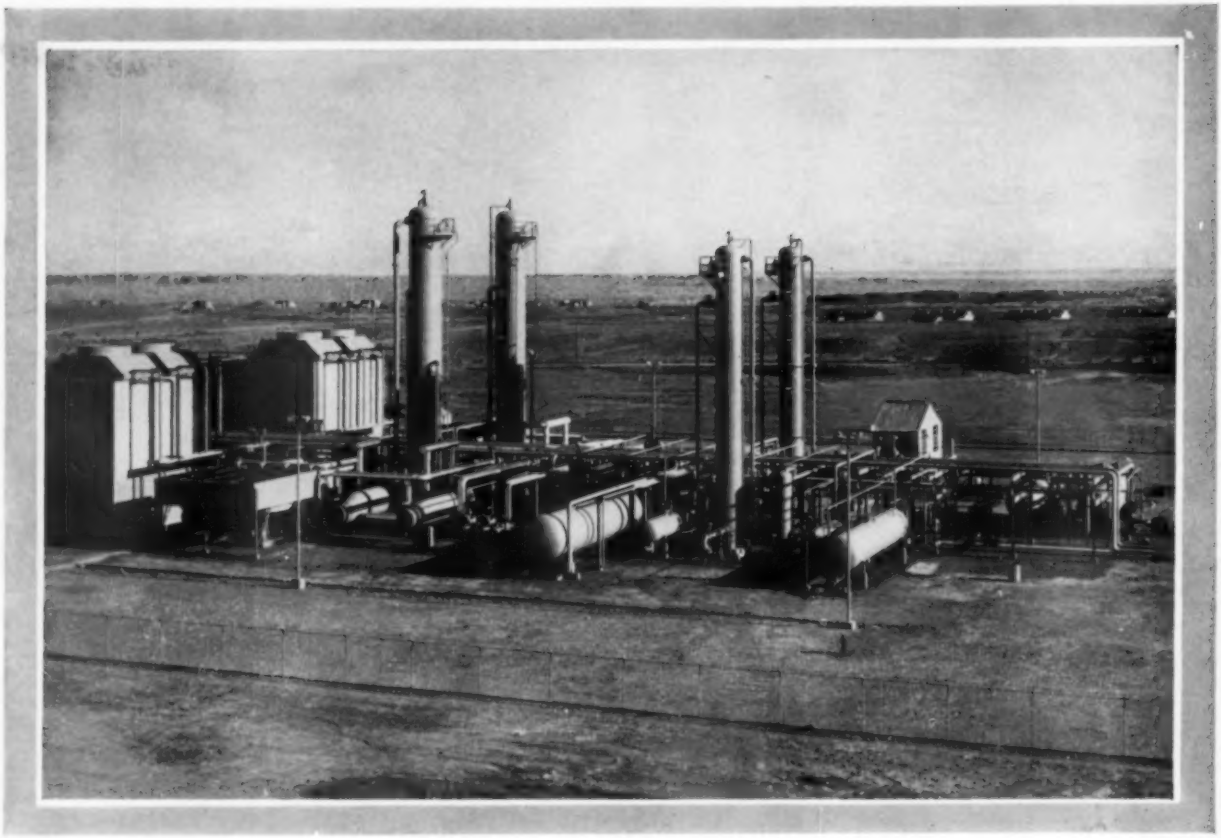
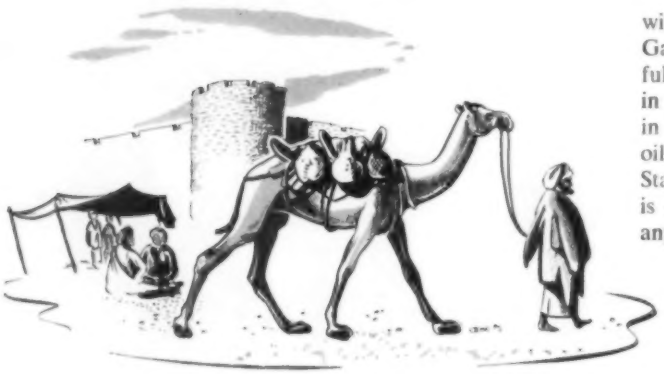


Sui GAS STARTS TO KARACHI

This plant, the first of its kind in Asia, is located in the Sui Gas Field 350 miles northeast of Karachi in West Pakistan. It processes sour gas, removing sulphur compounds and water vapor, preparing the gas for transportation and consumption. It is a vital part of a project from which will accrue great economic advantage to Pakistan.

The work of Hudson included design, procurement of equipment, transportation, and erection using English, American and native labor.

Despite the remoteness of the plant site, the rail terminus being 40 miles across the desert, and air temperatures as high as 125°F. in the shade, the plant was completed in 12 months from start of design work.



Hudson is proud to have collaborated with Pakistan Petroleum, Limited, and Sui Gas Transmission Corporation in the successful completion of this first project of its kind in Asia. The experience of Hudson gained in over 30 years in design and construction of oil and gas processing plants in the United States, Europe, Mexico and South America is available for any project large or small in any part of the world.

HUDSON

ENGINEERING CORPORATION

FAIRVIEW STATION • HOUSTON, TEXAS

South America starting in 1945. In 1948 Price became chief engineer and was elected a vice president in 1953.

Whitmor Homebuilders Awarded Housing Contracts

Whitmor Homebuilders, Inc., Tulsa, has been awarded contracts in excess of $850,000, it is reported by Burl Johnson, vice president, who is in charge of Whitmor's industrial-housing program.

Largest of the contracts was awarded by Texas Eastern Transmission Corp. to Whitmor for 50 houses to be constructed at compressor stations along Texas Eastern's pipeline in Texas, Louisiana, Mississippi, Tennessee. E. R. Blair, Jr., Whitmor sales manager who handled negotiations, reported that six homes will be built at each station site.

Other contracts include a group of 13 houses for El Paso Natural Gas Co. near Farmington, N. M., and a contract for Texas Natural Gasoline Corp. near Glendive, Mont. In addition to these new contracts, Whitmor is completing a project for Convair, a division of General Dynamics Corp., at Cocoa Beach, Fla., for 130 homes which are to be leased on a rental arrangement to Convair by Whitmor.

A-C All-Weather Motor Display to Tour Southwest

This mobile display is being used on a 1,500-mile tour by Allis-Chalmers Manufacturing Co. during May and June to demonstrate its weather-protected motors to industries in Oklahoma, Texas and Louisiana. Cities to be covered in connection with the tour are Tulsa, Shreveport, Beaumont, Houston, Corpus Christi, San Antonio, Dallas, Fort Worth, and Oklahoma City.

An open truck is being used to emphasize the motor's application as an all-weather drive. It is designed specifically to operate in extremely hot and cold weather, rain, wind, sand, dust, sleet, and snow.

Mobile unit visitors will have an opportunity to examine a 400-hp. motor weighing 4,000 lb. In addition, they will be shown displays of several exclusive features of the motor, including a special capsule-mounted bearing and the Silco-Flex insulation system.

DESIGNED, TESTED AND PROVEN IN THE OIL FIELDS

Screened Air Port

Unexcelled . . . for Outdoor Use

- DRIP PROOF
- VERMIN PROOF
- MOISTURE PROOF
- CORROSION RESISTANT
- FORCED AIR COOLED

All these features of Fieldmaster Ball Bearing Motors have been designed to overcome the rugged conditions of Oil Field requirements.

CHECK THESE OUTSTANDING ADVANTAGES.

Heavy Cast base for alignment, stability, heavy duty, double-shielded, prelubricated bearings, reduces lubrication worries, high grade silicon steel in the magnetic circuit reduces iron losses . . . Wide variety of windings provides triple ratings, dual voltages . . . high torque licks heavy starting problems. High slip is available to take care of reciprocating load requirements encountered in pumping.

FIELDMASTER

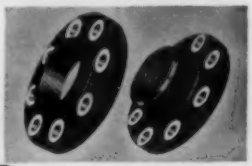
Write For Descriptive Literature.

BETHLEHEM SUPPLY CO. TULSA, OKLAHOMA

Manufactured by VALLEY ELECTRIC CORPORATION, St. Louis, 8, Mo.

No Magic,

Just Manufacturing Skill in



HARRISBURG FLANGES and COUPLINGS

No magic—just solid metalworking experience—is behind the high reputation of Harrisburg Flanges and Couplings.

Harrisburg Drop-Forged Steel Pipe Flanges are made to A.S.A. Specifications, in threaded, butt-welding, slip-on welding, Van Stone, and blind types. Special analysis steel, careful machining, shot-blasted surface, and rust-inhibitive black lacquer finish, all contribute to their high quality.

Harrisburg Couplings are made to A.P.I. and A.I.S.I. Specifications. Threads are electro-galvanized to prevent seizing and are accurate in form, height, angle and lead. Due to high quality standards, they are extensively used in oil well casings.

Send for Literature and prices.

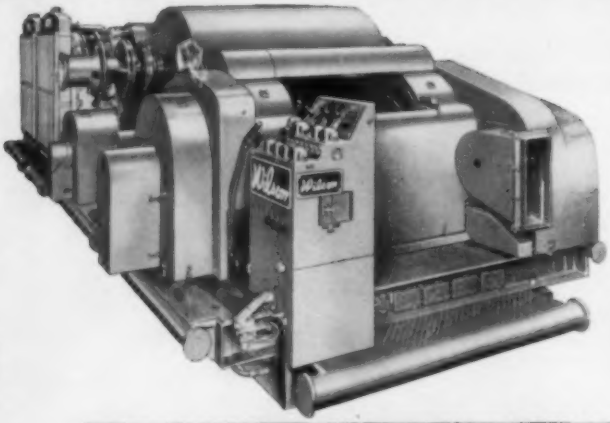
More than a century in Harrisburg

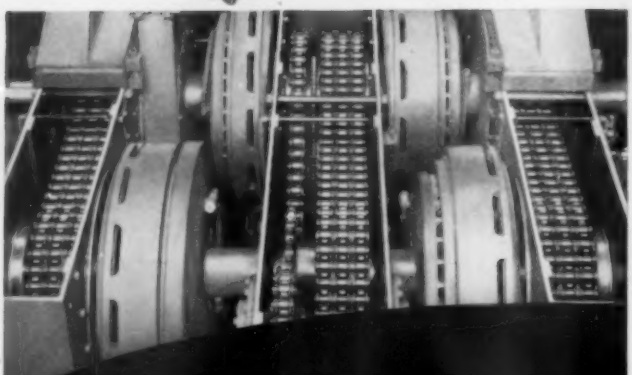
Harrisburg Steel Co.

Division of Harsco Corporation

Harrisburg 6, Pennsylvania

Performance Comes First With **WILSON!**





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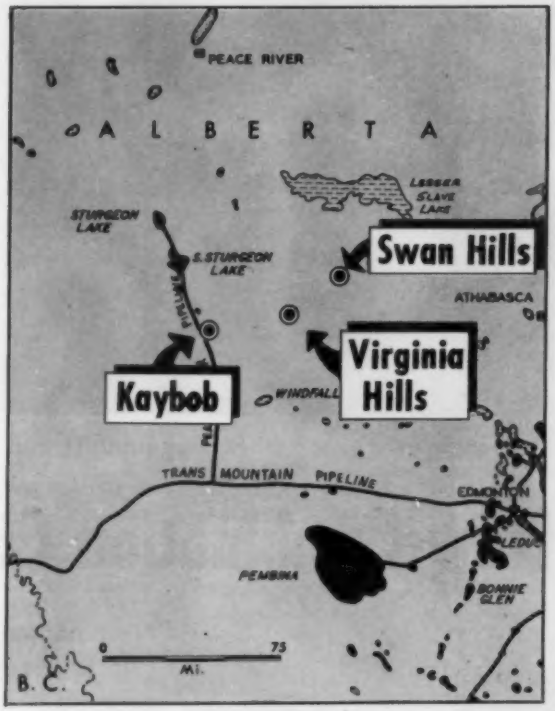
Please refer to the classified section of your local telephone directory under the heading CHAINS or CHAINS-ROLLER

Western Canada Gets Its "Really Big" One

By Frank J. Gardner



THREE big discoveries on the western plains of Alberta have given Canada its biggest successes since Pembina in 1953.

WHEN this reporter last roamed the Canadian scene in February of this year, one comment was heard more often than any other. "We need a really big discovery. We've had nothing really big, you know, since Pembina."

At the time, a lot of conversation centered around two new strikes that had just been reported 120 miles northwest of Edmonton. Few people realized then that the very discoveries they were wishing for had already happened. But as the reports drifted in, Canadians began to look anew at the big blank spot on the oil map—and a vast blank spot it was. Bounded on the north by Lesser Slave Lake, on the south and east by the Athabasca River, and on the west by the Peace River Pipeline, it covered roughly 6 million acres.

In virgin country . . . Smack in the middle of this virgin country, Home Oil Co., Ltd., et al. drilled its 9-20 Virginia Hills wildcat on LSD 9, 20-65-13w5. Early in February, the operator reported recovery of 5,000 ft. of clean oil on drill-stem test of the Slave Point-Devonian level at 9,228-57 ft. A second test at 9,259-85 ft. recovered 2,400 ft. of gassy mud and oil emulsion (50 per cent oil); earlier, the well had flowed 5.1 million cubic feet of gas per day from basal Blairmore-Cretaceous at 5,655-77 ft. Following the tests, Home Oil drilled the hole on down to pre-Cambrian at 10,624 ft., found nothing more, and plugged back to 9,445 ft. for production tests.

This first strike was interesting enough, but later in the same month, the same operators announced a second one at Swan Hills, 25 miles northeast of the original Virginia Hills find. This well, Home et al. 8-11 Swan Hills, lies on LSD 8, 11-68-10w5. On drill-stem test in the Slave Point at 7,785-7,923 ft., it showed a moderate gas flow and recovered 2,400 ft. of clean oil, 300 ft. of gas-cut mud, and 800 ft. of muddy water cushion. It was carried to the 9,000-ft. level. Final potential on both discoveries must await tests following the lifting of Canadian road bans.

The lid blows off . . . But the strike that blew the lid off was the third one in this western plains country, on May 1. At its 1 Kaybob, 35 miles southwest of the first Virginia Hills wildcat, Phillips Petroleum Co. announced a flow of 110 bbl. per hour on drill-stem test of the Slave Point (?)* at 9,572-9,625 ft. This big one lies on LSD 7, 22-64-19w5; previously, it had flowed 6 million cubic feet of gas per day from Viking-Cretaceous at 4,654-4,700 ft.

These three discoveries, coming as they did in quick succession, and tentatively all from the same formation, set off a wave of speculation and interest not seen in Canada since the Red Earth Creek discovery of 1956. Land around the new wells was not available as it was around Red Earth, so there was no leasing rush comparable to the 1956 spree. But their geologic and economic importance cannot be overlooked. Never before had the Slave Point produced commercial oil; it had produced showings in subcommercial amounts. If these are reef strikes, as many believe them to be, the Virginia Hills-Kaybob region may emerge as the greatest thing for Canada since Pembina. Few believe that they will evolve as one reservoir, but that is not beyond possibility. Two wells now drilling between Virginia Hills and Swan Hills will shed a lot of light on that nebulous chance. But a new reef trend may be shaping up.

*Phillips Petroleum Co.'s Bartlesville, Okla., office calls this producing horizon Cooking Lake.

And Canada has what it wanted . . . This is a region of large land holdings. The Virginia Hills discovery was drilled on a farmout to Home from Hudson's Bay Oil & Gas Co., Ltd., and Union Oil Co. of California; the Swan Hills was a farmout from Trinidad Leaseholds, Ltd.; and the Kaybob strike is on a farmout to Phillips from British American Oil Co., Ltd., and the California Standard Co.

Western Canada has what it wanted —a "really big" discovery.

. . . Photogeologist plus . . . stereoplotter gives——→

New Combination Gives Accurate Mapping

Now photogeology plus photogrammetry enable the geologist to work out outcrop patterns. Elevation data necessary for the structural contour maps is furnished by stereoplotting instruments. This new combination is expected to bring many benefits to the industry.

By Norman S. Morrisey
Drilling-Development Editor

TWO separate mapping methods combine to give the oil geologist an accurate and detailed structural picture of the surface geology. Photogeology plus photogrammetry now place a new tool in the hands of the oil finder. The aerial photographs enable the geologist to work out the outcrop patterns. Stereoplotting instruments give elevation data necessary for the structural contour maps.

Already this mapping method has proved its worth in areas of steep dip like Wyoming (see above figures) and in low-relief areas of the Mid-Continent and Texas where closures of less than 20 ft. are mapped. Stereoplotting machines can give elevations with an accuracy of 2.5 ft. if detailed mapping of low relief structures is desired.

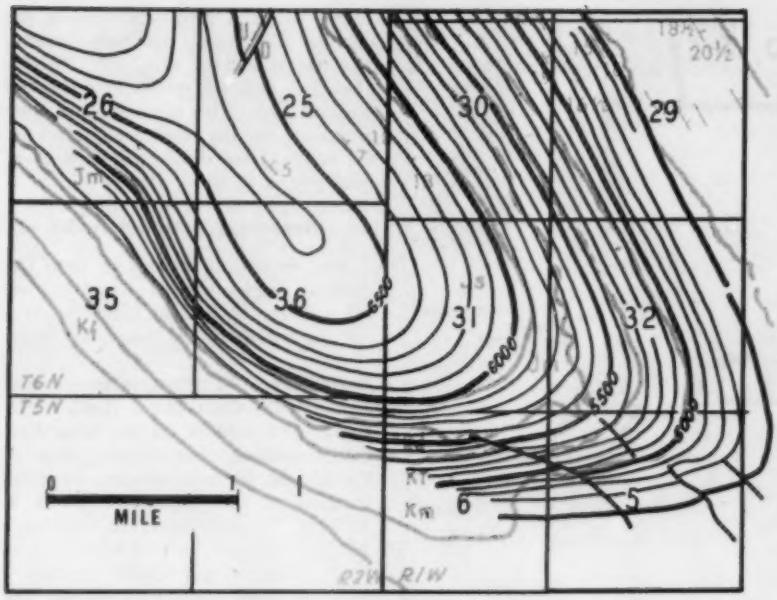
Advantages of method . . . Stereostructural contouring or structural contouring with aerial photographs in many instances is cheaper and more accurate than normal plane table surface mapping. Under highly favorable conditions, it is possible to construct an accurate structural map without entering the field. This, however, is unusual, because surface elevations are essential to insure correct results. And, in addition, it is wise to check the local stratigraphy "on the ground."

Skilled photogeologists and stereoplotters can map local low-relief structures that might be overlooked by normal field mapping methods. Also, faults not apparent to the surface geologist may be readily identified by a competent photogeologist.

Service now available . . . Aero Service Corp. (Mid-Continent), Tulsa, and Knox, Bergman & Shearer, Denver, are associated to provide this new mapping service to the industry. Aero Service handles the aerial mapping, surface elevation control, and stereoplotting. The consulting firm of Knox, Bergman & Shearer provides the photogeologic interpretation and subsequent structural mapping. The combined service is a natural outgrowth of the new technique that uses both aerial photography and photogeology.

How it works . . . Photogeologists carefully examine stereoscopic pairs of photos and work out the surface outcrop patterns. Usually this work is done using a magnifying stereoscope. The original aerial photography must be extremely high quality to insure accurate elevation control. Inferior cameras and lenses, improperly flown flight paths, poor or inadequate elevation control can render the subsequent structural map invalid. For this reason it may be impossible to use existing aerial photographs.

After the outcrop pattern is delin-



Detailed Contour Map

eated, transparent-glass photographic plates are made of each set of overlapping photographs. These plates are placed in a stereoplotting machine and the necessary structural elevation control is established. Probably the most widely used plotter is the Kelsh. It is so constructed that light rays projected through the two photographic plates coincide to produce an image on a circular disk or platen. The operator views the projection through colored glasses; one lens red, the other blue. The resulting picture is a three-dimensional view of the outcrop. A floating bead in the center of the platen is used to determine the elevation. If the bead is in contact with the ground, the instrument will automatically register the ground elevation at that particular point. The operator follows the outcrop pattern in the photographs with the bead, and on key marker beds, he determines the actual elevation at desired points.

The outcrop pattern and the datum points are then turned over to the photogeologist for structural analysis. The final result is a detailed surface structural map coupled with areal geology and key bed patterns.

Ground control essential . . . To insure accurate structural maps, surface elevations are needed for each set of overlapping photographs. Normally four elevations are obtained for each set, and the elevations are positioned in the corners of the overlap area. In areas of considerable structural relief, aneroid barometer elevations are sufficiently reliable for determination of ground control. In remote or inaccessible areas, aneroid elevations can be run on key points using a helicopter. In areas of low structural relief, however, ground elevations must be correct to 1 or 2 ft. This means ground surveys that are carried out by field parties.

The known elevations are used in the stereoplotter so that the machine will correctly register surface elevations at any point within the area.

Costs for stereostructural contouring vary greatly. Both the availability of suitable aerial photographic coverage and the ground control necessary for elevation data influence costs. Remoteness of an area poses no serious problem to this new technique. Photogeologists agree that the new technique can be carried out for considerably less cost than a surface-mapping program in the same area. Moreover, the time factor favors the stereomapping technique.

Advantages for industry . . . The new mapping technique will permit the oil finder to broaden exploratory procedures in his search for new reserves. Photogeology plays an important role as a reconnaissance tool in oil exploration and photogrammetry is recognized as the most favorable means of constructing topographic maps. The combination of the two mapping techniques is expected to bring a fourfold benefit to the industry: (1) reduced costs for reliable surface mapping, (2) no area exclusion due to remoteness, inaccessibility, etc., (3) "year-'round" surface mapping programs, and (4) rapid compilation of surface structural data. **End.**

EXPLORATION HIGHLIGHTS

APPALACHIAN

OHIO

Rank Test Slated Near Washington Court House

Kewanee Oil Co. has staked the first location on its large block of acreage near Washington Court House on 1 E. A. Hopkins, Tract 663, Union Township, Fayette County. The rank wildcat will test formations down to the granite in an area in which little deep geology is known. A gravity survey revealed the presence of a pronounced anomaly extending through Fayette County.

- Natol Corp. stepped out nearly a mile south of production and brought in a 140-bbl. well on 1 Paul Jones, Section 18, Jackson Township, Muskingum County. Clinton was found at 3,146-3,205 ft. and had a fair showing natural.
- E. M. Shields 1 Clearfield Coal, Section 28, Clayton Township, Perry County, a north offset to their 1 Coulter, logged the Clinton at 3,350-3,400 ft. with 5 bbl. natural and 100 bbl. in 24 hours after fracture.

WEST VIRGINIA

In Edray district, Pocahontas County, West Virginia, Logan Gas Development Co. 1 Cherry River Boom & Lumber Co., wildcat, elevation 3,432 ft., was dry. Benson sand 4,155-4,200 ft. Total depth 4,504 ft.

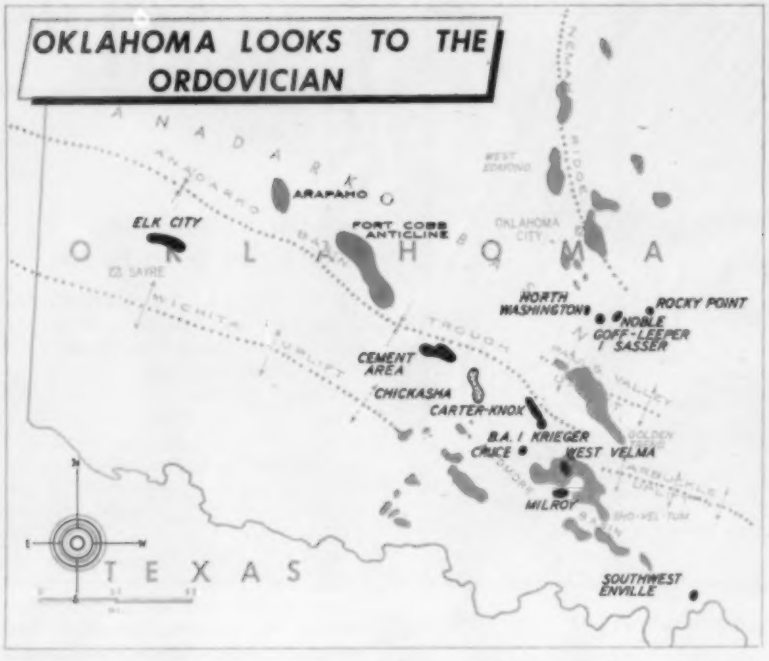
PENNSYLVANIA

In Young Township, Indiana County, Southwest Pennsylvania, James Shearer completed 1 L. Azzelio with a final open flow of 400,000 cu. ft. of gas after fracturing the second time. The Oriskany sand was at 7,682 ft. with gas at 7,692 ft., first testing 800,000 cu. ft. Total depth was 7,692 ft.

- In East Whitfield Township, Columbian Carbon Co. 1-1839 is drilling in chert which was reached at 8,144 ft.

EASTERN KENTUCKY

In Magoffin County and located on Puncheoncamp Creek, Kentucky West Virginia Gas Co. have completed 6373 Ulysses Higgins as a Silurian Big Six sand gas well. Producing formation was topped at 2,667 ft. with first gas showing at 2,670 ft. To total depth of 2,713 ft. gas flowed naturally at the rate of 660,000 cu. ft. daily which, after shot, increased to 794,000 cu. ft. Rock pressure was 550 psi. in 48 hours.



ULTRADEEP SANDS of Ordovician age indicate tremendous potential for Oklahoma's Anadarko basin. State's deepest production, 15,000 ft., is found here.

Sooner Wildcatters Sight Anadarko's Deep Sands

by John C. McCaslin
District Editor

OKLAHOMA wildcatters are preparing to tee off on the deepest exploratory and development campaign in the state's long oil history. The objective of this oil hunt is the ultradeep sands of Ordovician age in the vast Anadarko basin. These Ordovician rocks indicate tremendous potential as prolific oil producers.

Knox Deep

The catalyst for this intense Ordovician interest in Oklahoma is British-American Oil Producing Co.'s prolific campaign at Carter-Knox field in Grady and Stephens counties. The company established the state's deepest production here last year below 15,000 ft. in the Bromide sands. The Knox area is studded with deep development wells aimed for these flush sands. Recently British-American's 1 Krieger in northeastern Stephens County extended the Knox play into that area, finding gas-distillate production in the second Bromide sand at 14,807-14,918 ft. (7,000 M.c.f. of gas and 315 bbl. distillate). This well is structurally higher than other deep tests at Knox, and the company may take the wildcat down to the Oil Creek and Arbuckle sands near 17,000 ft.

The Knox drilling spree has tapped production in the Viola lime, second and third Bromide sands, leaving the lower sands of Ordovician age yet to be evaluated. Deep drilling plans at Knox are expected to span an area of 15 miles northwest-southeast. All signs point to a productive area in the Ordovician of broad extent.

British-American will drill 1 Nellie English in SE SE NW 19-3n-5w, on the northwest side of the deep play at Knox in Grady County. The 16,100-ft. test is their sixth in the area. Five other wells are drilling toward deep Ordovician objectives, or are already producing. Pan American Petroleum Corp. is busy at another.

Elk City . . . Shell Oil Co. will go to 17,000 ft. at a geological wildcat inside Elk City field, Beckham County. The test is located in C SW 16-10n-21w. The drill will probe into the Ordovician beds. This company has four producers on the lease which will be the scene of the deep wildcat. Regular field pay is at about 10,000 ft.

Ordovician Interest Spreads

The resounding success of deep Ordovician exploration at Knox has set off a flurry of wildcat plans throughout the trough of the Anadarko basin.

Fort Cobb . . . Kenneth Ellison and Texolina Oil Co. will put down a 20,000-ft.-plus wildcat on the huge Fort Cobb anticline that crosses parts of Caddo and Washita counties. Reported location of this important test is 4-9n-12w. The expensive test will begin late this summer. Several wildcats have been drilled on this elusive structure—most of them finding oil shows. The big structural feature contains enticing possible reservoirs of Ordovician, Devonian, Silurian, and Pennsylvanian rocks.

East Cement . . . Pan American Petroleum Corp. reportedly will drill a deep one on the East Cement dome looking for Ordovician sands above 17,000 ft. East Cement is structurally higher than West Cement where Ordovician development is in progress.

Other structures expecting Ordovician tests are West Velma, Cruce, Chickasha, and Arapaho.

Ordovician Roundup

South-central Oklahoma is enjoying a real boom in Ordovician activity, particularly in McClain and Cleveland counties.

. . . **Anderson-Prichard Oil Corp.** got 100 bbl. of oil per hour on tests of the Bromide sands at the 1 Westbrook in 3-7n-3w, North Washington area. Oil flowed from the Ordovician at 10,460-81 ft., extending Washington area production.

. . . **Southwest of Noble,** Goff-Leeper Drilling Co.'s 1 Sasser in SE SE 8-7n-2w flowed 400 bbl. of oil per day on final tests of the Bromide sand at 8,291-98 ft.

. . . **Considerable development** is under way in the Moore, West Moore, Noble, and Rocky Point areas of Cleveland County. Production at Noble and Rocky Point is from both the Bromide and Tulip Creek sands. Moore area has Bartlesville-Pennsylvanian and Hunton-Siluro-Devonian production. Oil Capitol Corp. 1 Fessenbeck, NW NE SE 32-8n-1w, extended South Rocky Point

field with production from Bromide and Tulip Creek sands at 7,464 and 7,738 ft., respectively. The well made 50 bbl. per hour. New wildcat locations and current drilling tests in Cleveland County make it one of the state's busiest.

...In the extreme southern part of the state, The Texas Co. opened a prolific and seemingly large Ordovician reservoir east of Marietta in Love County. The 1 Westheimer flowed gas-distillate from the Oil Creek sands, opening Southwest Enville pool.

...A new upsurge in Ordovician exploration is noted in the Madill and Aylesworth areas of Marshall County in southern Oklahoma. Jones Oil Co. will drill a 7,000-ft. test in 24-5s-5e.

...Gulf Oil Corp. 1 Bowers-Sims, NW SW 13-2s-4w, is a Viola lime Ordovician discovery at Milroy in Stephens County. The well flowed 8 bbl. of oil per hour from the Viola at 5,045-60 ft., and also made 2,900 M.c.f. of gas from the Hunton at 3,590-4,072 ft.

OKLAHOMA

NORTHWEST OKLAHOMA

Morrow Gas Flows at Ellis County Wildcat

A revival of production in Ellis County is hinted at a Shell Oil Co. wildcat, the 1 Peetoom in NE NE SW 29-24n-25w, 10 miles south of the booming Laverne gas district of Harper County.

Shell's well is an indicated Morrow gas discovery at 8,032-42 ft. Flow on ½-in. choke was 2,050 M.c.f. of gas daily. Another test got 1,450 M.c.f. per day on same choke.

Location of this possible discovery well is 7 miles northwest of South Salon pool, an abandoned gas-distillate producer.

Big Hoover Gas Well Finaled at Laverne

Open flow test of Cities Service Oil Co.'s well in C N½ NW SE 14-26n-25w, Laverne district, Harper County, flowed 50,000 M.c.f. of gas per day from perforations at 4,180-4,220 ft. in the Hoover-Pennsylvanian sand.

Gate Lake field . . . The fourth producer in this Harper County field is Keating Drilling Co. 1 Allen, NW NW SE 14-28n-26w. A drill-stem test at 6,340-6,475 ft. showed gas, and another one in the Morrow at 6,310-35 got 1,302 M.c.f. per day.

Southeast Stockholm Field Adds Two New Producers

Two wells were added to the new Southeast Stockholm field in Harper County. Pure Oil Co. 1 Palmer in C NE NE 29-26n-23w, flowed gas-distillate on drill-stem test at 5,489-5,515 ft. Eason Oil et al 1 Palmer in C SW NE 21-26n-23w, is flowing 9½ bbl. of oil hourly by head from perforations at 5,488-96 ft. in the Tonkawa-Pennsylvanian.

The 1 Campbell in C NE SW 8, northwest extension well, recovered 2,350 ft. of heavily gas-cut mud on a 2-hour test at 6,743-87 ft.

OKLAHOMA PANHANDLE

Dual Gas Strike Finaled In South Glenwood Area

The South Glenwood area of Beaver County picked up a dual gas discovery with completion of Shell Oil Co.'s 1 W. A. Lonker "B" in C NE SW 35-6n-27eCM.

The Morrow well flowed 1,016 M.c.f. of gas per day plus 12 bbl. condensate on 1-in. choke from perforations at 6,078-93 ft. From the Mississippian-Chester it made 2,426 M.c.f. of gas plus 4 bbl. condensate on 1-in. choke from perforations at 6,160-69 and 6,206-73 ft.

SOUTHERN OKLAHOMA

Deep Stephens Area Adds Fourth Producer

The fourth well in a new Oil Creek-Ordovician deep reservoir in Stephens County was reported. The Texas Co. and Mercury Drilling Co. 1 Elliott, SE SE 5-2s-4w, flowed 210 bbl. of oil on ¼-in. choke for 11 hours. Perforations are at 8,679-8,718 ft.

East Marlow Field Gets Second Well

The second producer in Stephens County's new East Marlow field was completed by Magnolia Petroleum Co., the field discoverer. The 1 Hobbs, NE SW SW 13-2n-7w. flowed 297 bbl. of 39°-gravity oil from perforations in the Ostracod at 8,315-34 ft. Choke size is 12/64-in. The pool allowable is 61 bbl. per day per well.

First Bromide Flows at Northwest Lindsay Well

Sinclair Oil & Gas Co. tested the 1 Rice estate in Northwest Lindsay field, McClain County, getting 70 bbl. of oil per hour and 7,000 M.c.f. of gas per day from perforations in the first Bromide-Ordovician at 11,226-71 ft. Sinclair will test lower zones.

WESTERN OKLAHOMA

Casing Run at Beckham County Discovery Well

Shell Oil Co. et al 1 Boyd, C NW NW 15-9n-22w, southwest of Elk City field in Beckham County, flowed 3,250 M.c.f. of gas per day on drill-stem test at 10,051-10,137 ft. The operator has run casing. Total depth is 10,205 ft.

NORTHERN OKLAHOMA

Large Flow Reported at Noble County Strike

A Cleveland sand discovery in Noble County flowed 256 bbl. of new oil in 4 hours on 30/64-in. choke, then 14 bbl. per hour on 18/64-in. choke plus 2,000 M.c.f. of gas per day. The discovery well is Wilcox Oil Co. 3 Carl, SW SE SW 17-20n-1e. Perforations are at 4,206-16 ft.

Ponca City Area Field Extended

A Burbank sand well in Southwest Ponca City field, Kay County, extends that producing area. Berry and Fick 3 Leathers, NE NE NW 14-25n-1e, flowed 34 bbl. of new oil per hour on 22/64-in. choke on completion.

Northeast Cherokee Field Extended in Alfalfa

Northeast Cherokee field in Alfalfa County was extended northeast at Continental Oil Co. 1 Marsh, C SW SW 20-27n-10w.

The well flowed 6,000 M.c.f. of gas per day from basal Pennsylvanian perforations at 5,146-81 ft. Below 5,160 ft. where packer was landed the well flowed 30 bbl. load oil and 50 bbl. new oil in 5½ hours on 20/64-in. choke. An east offset to this well is planned.

Exploration This Week

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ROCKY MOUNTAIN

UTAH

I.A.P.G. Announces Uinta Basin Field Trip

The Intermountain Association of Petroleum Geologists announces a field trip through the Uinta basin and Uinta Mountains June 20-22. This group has conducted annual field trips in Utah since 1950 and published geologic guidebooks in conjunction with the field conferences. The group is presently headed by Robert J. Minton, Rocky Mountain manager for American Petrofina, Inc.

Notwithstanding the importance of the currently booming Paradox basin, the geologic concept and belief has not dimmed that the unique Uinta basin will eventually take its place among the great producing sedimentary basins of the world. Recent successes in the basin by El Paso Natural Gas Co. and Havenstrite Oil Co. and Sun Oil Co. have lent credences to the belief that immense quantities of gas have been overlooked by previous drilling, as a result of prejudiced geologic thinking, faulty engineering and obsolete completion practices. The geologic advancement in the Uinta basin is reemphasized by the fact that the 1957 field trip is the first repeat trip in the history of I.A.P.G. The first Uinta trip was in 1950.

The new guidebook will include articles by leading national authorities, many of whom will also speak at their respective stops along the route. Field trip chairman is D. A. Preston, Shell Oil Co.; registration manager is John Scheufler, Box 34, Salt Lake City. Field trip publicity is being handled by Graham S. Campbell.

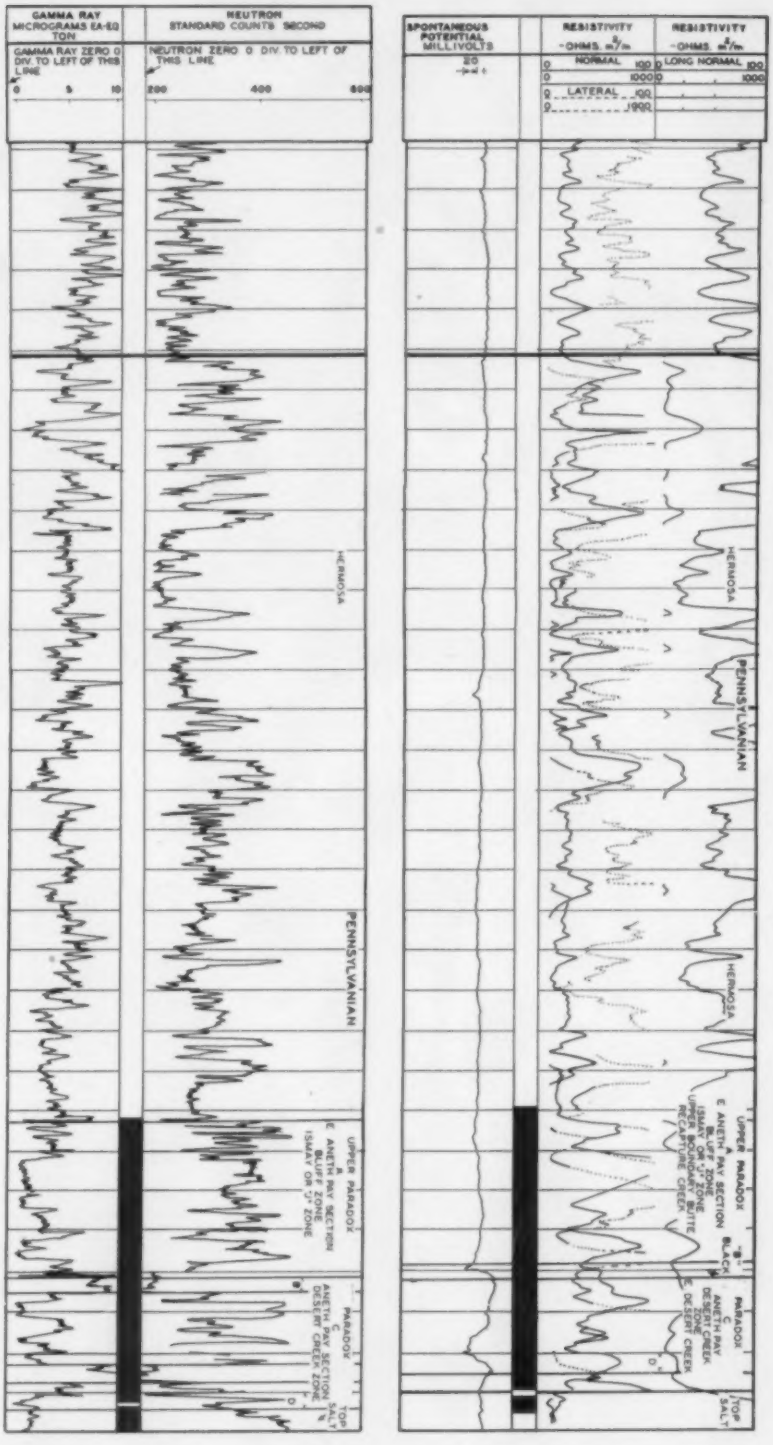
Deadline for registration is June 1. Registration will be on June 19 in the afternoon and evening at the Vernal Hotel in Vernal, Utah.

Carter Reports Big Flow at San Juan Well

Another prolific addition to the Aneth area of the Paradox basin is Carter Oil Co.'s 1 Navajo-114, SW NW NW 8-41s-25e, San Juan County. The well flowed oil at the daily rate of 1,109 bbl. on 5/8-in. choke from perforations in the Pennsylvanian at 5,466-5,560 ft.

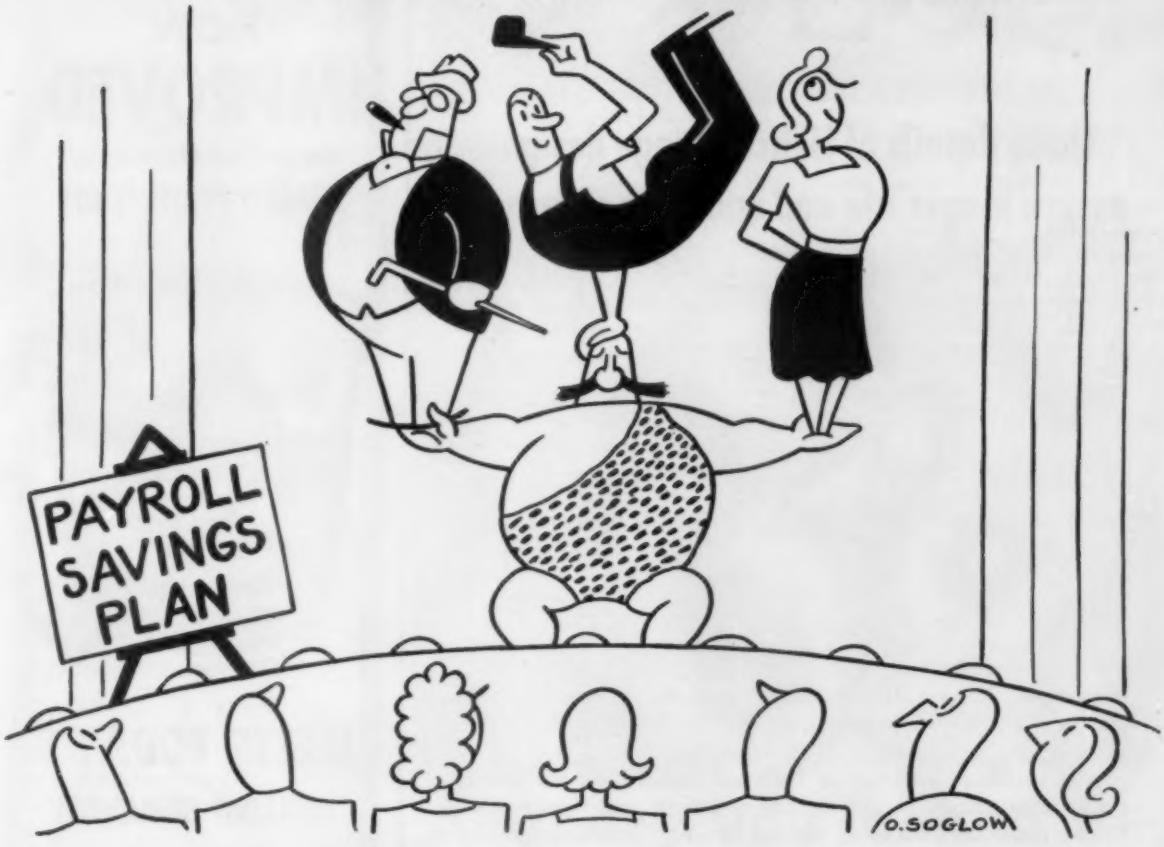
This well is 4 miles northeast of East Desert Creek field and about 1½ miles south of a Superior Oil Co. discovery in 31-40s-25e at the southeast end of Aneth field proper. The discovery opens first production in 41s-25e.

Paradox Basin Logs



TYPICAL LOG OF PARADOX BASIN shows the prolific Pennsylvanian section that is making exploratory history in southeastern Utah. The basin now boasts 17 oil and gas fields, all but four of them in San Juan County, Utah. Most production in the basin is from the Paradox-Hermosa (Aneth pay, Desert Creek zone). The upper Paradox-Bluff, Ismay, or "J" zone produces at Recapture Creek, the Boundary Butte fields, East Aneth, and the Arizona gas fields. (Log courtesy Schlumberger Well Surveying Corp., Denver.)

"Got A Load On Your Mind? I Haven't"



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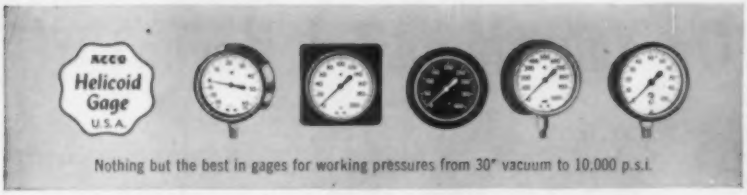

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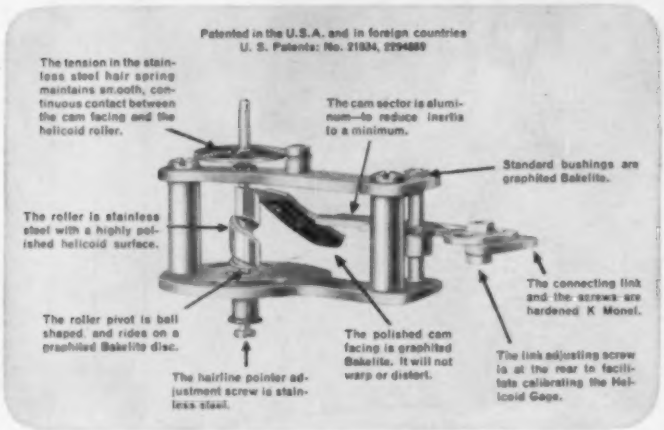
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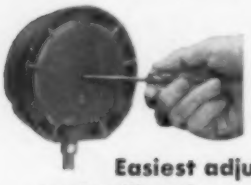

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NORTH DAKOTA

Bottineau County Wildcat Recovers Mission Canyon Oil

Oil was recovered on a drill-stem test at 3,974-82 ft. in the Mission Canyon-Mississippian at Carter Oil Co. and Phillips Petroleum Co. 1 Fossum, C NE NE 31-162n-81w, Bottineau County.

Recovery was 675 ft. of gassy oil, including 200 ft. muddy, gassy oil and 5 ft. slightly salty water. Another test in the same formation at 3,972-77 ft. got some oil cut mud and 240 ft. of gas-cut sulfurous free oil. The Charles-Mississippian at 3,786-91 ft. gave up 125 ft. of heavily oil and gas-cut mud, 205 ft. gas-cut free oil and 120 ft. salt water. The operator took another test of the Charles at 3,790-98 ft.

Location of this northeastern Williston discovery prospect is 10 miles southeast of Haas field, a Mission Canyon producer, and 11 miles southwest of Charles production in Kuroki field.

WYOMING

Pennsylvanian Oil Found At Donkey Creek Well

Another well in Crook County's Donkey Creek field in the Powder River basin's northeast side found oil in the Pennsylvanian. The Texas Co. got 1,615 ft. of black gassy oil on a test at 7,832-7,900 ft. at its 1 Stevenson NCT-2 in C SW SE 8-49n-68w.

This significant well is the second in this field to get oil from the Pennsylvanian. True Oil Co. recently completed a Minnelusa discovery at B-6 Burrows in C NE NW 8-49n-68w, for 28 bbl. per hour from perforations at 7,727-47 ft.

This field is a Cretaceous producer, and the Pennsylvanian discoveries have paved the way for a new deep drilling era in this portion of the basin. This north part of the Powder River country has only two pre-Cretaceous areas, Adon and Mitchell Creek.

NEVADA

Nevada Activity

Standard Oil Co. of California was scheduled to begin drilling on 1 County Line in NW NW 19-10n-62e, the fifteenth of this month. This is about 24 miles slightly north and east of Shell Oil Co.'s production at Eagle Springs.

In other Nevada activity, Bonanza Oil Corp. has temporarily suspended drilling at 634 ft. of 1 Consolidated near Arden in Clark County. In other Clark County drilling, Matador Oil Co. has shut down operations on 29-1X Well southwest of Las Vegas at 1,320 ft. Moapa Oil & Gas Co. has moved off the rig on 1 Logandale which has been idle since March 3. Total depth is 595 ft.

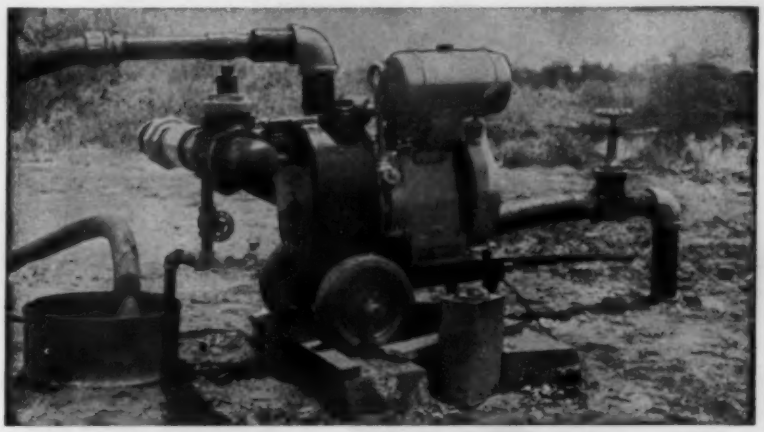
CALIFORNIA

Atlantic Readies Prado Test

Atlantic Oil Co. was preparing to gun perforate for production on 1 Atlantic in Riverside County, the first extension test of Lyle Garner's new field discovery near Prado Dam. Atlantic cemented casing to 3,851 ft. in the well, located ¼ mile northwest of Garner's well. Total depth is 3,853 ft.

New Guijarral Pool

L. A. Harnish, operator, tapped a new deep pool in Guijarral Hills field, Fresno County. The discovery, E53-34F Allison, unloaded over the crown block for more than 2 hours during a formation test of a lower Gatchell sand at 10,225 ft. The crew was pulling pipe when the well unloaded. The



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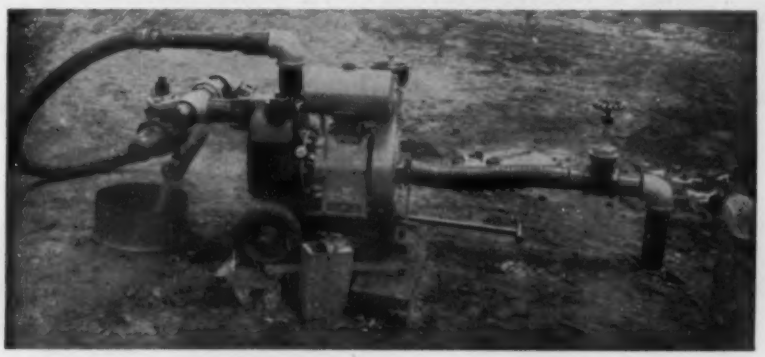

formation test recovered a gross rise of 9,950 ft. with a 2,200-ft. water cushion. The operator reports the well has more than 200 ft. of productive sand. Location is in SW NE 34-20s-16e. Standard Oil Co. of California, Sunray Mid-Continent Oil Co., Continental Oil Co. and Union Oil Co. have adjoining acreage.

Humble Completes Fillmore Extension

Humble Oil & Refining Co. dually completed 1 May Easton for an important extenson of Fillmore field, Ventura County. Humble's well is midway between Richfield Oil Corp.'s 1 McNab which is the most eastern well in the field, and the Humble-Standard activity in the main area. This new well was brought in flowing 688 bbl. daily of 34.3°-gravity crude through a ¼-in. choke. The producing zones are at 13,770-13,832 ft. and 13,912-60 ft.

PACIFIC NORTHWEST

Standard Oil Co. of California was drilling below 5,251 ft. on 1 Kirkpatrick near Condon in Gilliam County, Oregon.

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• In Washington, McCulloch Oil Exploration Co. was drilling below 3,728 ft. on 1 Pasquier in the Enumclaw area, King County.

ARIZONA

Wildcat Activity Reported In Northwestern Arizona

Location has been staked for a wildcat in 12-40n-6w, Mohave, Arizona, by Tracy Word of Houston. Another well was staked 6 miles south by Tony Lyons and Paul Poteet of Holdenville, Okla., in SW SW NW 14-39n-6w. Cable tools are now on location. These two wildcats will test the Permian zone, through the Coconino sand or to 2,500 ft.

This area lies between two major faults shown on tectonic maps. Hurricane fault lies on the west side, and Seveir fault on the east side.

Harry E. Weaver and S. E. Adams of San Angelo and Tony Lyons have under lease 70,000 acres in this immediate area. The block is 10 miles east of the Sinclair, Continental, Valen Oil Co., and Falcon Seaboard test drilled last summer in 28-40n-8w. This well lost circulation in the Mississippian at 3,710 ft., after having drilled 400 ft. of the Mississippian.

Western Drilling Co. of Lubbock will drill a third wildcat within 45 days about 8 miles south of the Lyons-Poteet well in 31-38n-5w. This one will be a 4,500-5,000-ft. test of the entire Paleozoic section and should bottom in the Tapeats sand of Cambrian age.

Geologically, this area lies along the broad southeast shoreline of the Great Basin. The section receiving the present activity is between the two above mentioned faults which lie about 30 miles apart. Local east-west cross faulting in combination with southwest dip forms the structural closure in an area where northeast regional dip is prevalent.

CANADA

ALBERTA

Third Pay Indicated At North Calgary

A third productive zone in the immediate Calgary area of Alberta has been discovered by Jefferson Lake Sulphur Co., according to a report from an unofficial but usually reliable source. The report stated that the well, Jefferson Lake-CPR 27-6 North Calgary, on LSD 6, 27-25-29w4, gave up condensate bearing gas from the Mississippian for-

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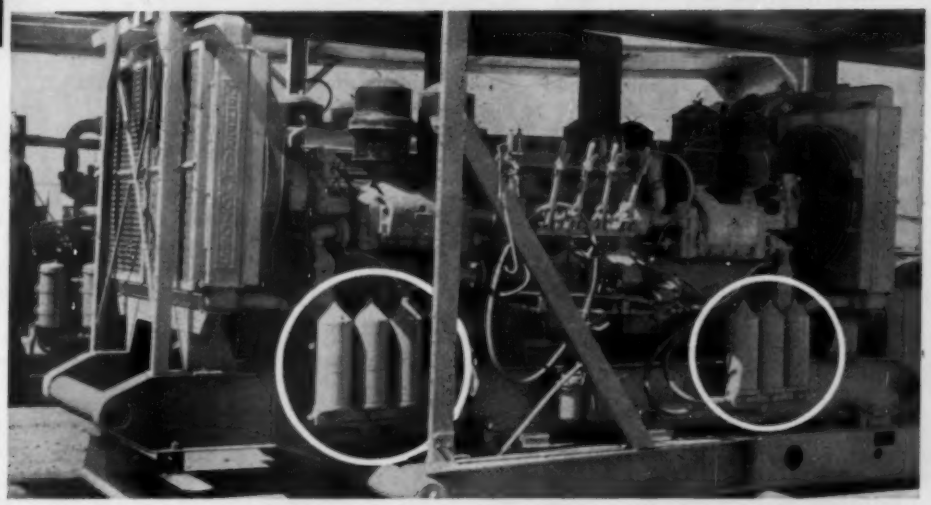
FILTERS

Case History Report No. 37 Shows Why Engines Protected by WINSLOW FILTERS Last Longer



LUBE OIL KEPT CLEAN A MONTH INSTEAD OF A WEEK *with Winslow CP* Filters*

Porter-Loughlin Company of Odessa, Texas, one of the largest Texas oil drilling companies, operates many drill rigs. Power for some electric generators is supplied by a quad installation of four 6-71 GM engines. The engines run 24 hours a day—a real tough test on lube oil—on filters and on engines.

With original filter equipment, oil and element changes were made every week. Since the installation of WINSLOW B-74 Full-Flow Filters, with CP* elements, oil and elements are changed only once a month or after 720 operating hours.

That's important in operating costs, and other big savings are longer engine life and lower maintenance cost, with the use of Winslow Filters. Ask about the application of modern CP* filters for all your powered equipment.

CP* FILTRATION

Winslow patented CP* (Controlled Pressure) elements are designed to continuously self-adjust the pressure within the filter and allow for a full stream of filtered oil without opening by-pass valves. This is accomplished through the dual flow capacity, with two types of material in the same element.

**CP is fully protected by patents and trademarks*

WINSLOW ENGINEERING & MANUFACTURING COMPANY
4069 Hollis Street, Oakland, California

W-2593-A

mation during recent tests conducted at it. This drilling project, which involves two wells in the vicinity is being held "tight" by the operator and consequently there is very limited information available on it. Both of those tests were initially set up to test for Devonian gas producing as Mobil Oil of Canada, Ltd., has had wildcat success in that zone at three other drillers in the area. As well as the gas discovered at those Mobil wells there is also a high percentage of sulfur and Jefferson undertook to prove sufficient gas reserves in the area to enable it to construct a sulfur plant with an initial capacity of 350 long tons of that product per day. The other producing horizon in the Calgary vicinity was discovered this spring by Western Leaseholds, Ltd., when a well drilled primarily for the Devonian gas was completed in the Cardium sand as an oil producer.

This project is being carried out by Jefferson on acreage farmed out to it by Mobil Oil of Canada, Ltd. Jefferson, which is the third largest producer of sulfur in the world, is supplying full costs of the development which is being carried out on an 80,000 acre block covered by the agreement.

The new discovery, 27-6 North Calgary, lies 2¼ miles northeast of Calgary's city limits, almost 6 miles north of the other Jefferson Lake driller, 27-11 Calgary, which incidently found the Mississippian water-bearing, and is 6 miles west-southwest of the Mobil-C.P.R. 3-2 Kathryn Devonian gas success.

The Mississippian formation, according to the unofficial information, was contacted around the 7,300-ft. level and the intervals of three tests covered a 130-ft. zone in the Elkton portion of that horizon, below 7,350 ft. The initial test evaluation gave up gas at rate, 500,000 cu. ft. daily while the next test flowed condensate-bearing gas at rate 4,000,000 cu. ft. daily. There was also a 300-ft. condensate recovery made in the drill stem at the conclusion of it. Last test reported flowed gas at a maximum rate of 5,700,000 cu. ft. daily and also gave up 430 ft. of condensate and some oil-cut mud.

Mobil Places Well No. 500 on Production

Mobil Oil of Canada, Ltd., this week placed its five hundredth well at Pembina on production. But it will produce for only a few months before being converted as a water injection well in the largest pattern flood conservation project ever undertaken by one company. The scheme will increase the ultimate oil recovery from the Cardium sand producing horizon by as much as threefold.

Since the discovery well was brought in by Mobil Oil, in July 1953, Pembina has developed into the greatest oil reserve in Canada. It is also the largest oil field, in area extent in North America. There are presently 1,749 wells capable of production in the field and during the last week on record a daily average production of 86,889 bbl. was taken from them.

Most operators in Pembina are now planning for greater long-term oil recovery through pressure maintenance programs and eventually almost one-half of the field wells will be converted to some form of fluid injection. Mobil Oils' engineers have been operating a pilot water injection scheme in Pembina since December 1956 to provide themselves with detailed information on the formations, characteristics, and the best methods for improving the total long term recovery. About 15,000 acres will be brought into scheme this year and another 25,000 acres are planned for later development.

QUEBEC

At Bald Mountain 2 Batiscan, 1,250 ft. southeast of the discovery well, drilling is proceeding below 1,665 ft.

At Bald Mountain 1 Berthier, 58 miles southwest of the discovery well, the hole is down to 2,050 ft.

At Bald Mountain 2 Portneuf, 25¼ miles northeast of the discovery well, drilling is proceeding below 975 ft.

At Bald Mountain 1 Cap Sante, 30¼ miles east-northeast of the discovery well, the hole is down to 663 ft. At 655 ft. a gas blow was encountered and at 663 ft. the well makes gas steadily through a water column, originating from 558-580 ft.

Drilling has been stopped and AX casing will be set and cemented at 640 ft., in preparation for testing.

ANTICOSTI ISLAND

Wildcatting Due on Isle In Mouth of St. Lawrence

Reports from Eastern Canada state that Associated Developments, Ltd., an independent Quebec operator, will drill on Anticosti Island in the mouth of the Gulf of St. Lawrence. The drilling will be carried out some time this year on a 2,000,000-acre block. The same company has 1,500,000 acres on Gaspe Peninsula. Rig is moving onto Anticosti for the first attempt.

The geology of this island is similar to the Quebec Lowlands where considerable exploration is now under way, and with considerable success. There has been no drilling on Anticosti. The

Plans have been announced for exploring for oil and gas on the Island of Anticosti in the Gulf of St. Lawrence. This will be the first drilling on the isle.

island covers about 3,000 sq. miles and is underlain by Ordovician and Silurian sediments. On the north side of the island the thickness of sediments is about 1,500 ft. and on the south about 3,500 - 4,000 ft. According to Roliff the total volume of sediments amounts to about 1,500 cu. miles of which about 80 per cent is limestones and dolomites, 17 per cent shales, and 3 per cent sandstones. Roliff states that regionally the beds dip southerly at gentle angles from zero to 5° or 6°, and some local structures are known. Coral reefs are present in the Ellis Bay-Silurian and other formations. The Chazy and Beekmantown outcrops on the north shore of the St. Lawrence River are similar in character to these formations in the St. Lawrence Lowlands.

There has been considerable exploration on the Gaspe Peninsula in recent years. Up to April this year 72 wells had been put down in this area.

SASKATCHEWAN

Steelman Becomes Province's Biggest Field

Southeastern Saskatchewan's Mississippian Steelman field is now the largest field in the province. The Department of Mineral Resources united Frobisher, Kingsford, Lampman, and Steelman into one large producing area. The Steelman producing area now covers 154,880 acres. The total number of producing wells stands at 430.

ILLINOIS BASIN

ILLINOIS

One Oil Pool Discovered in Illinois in April

One new oil pool, Corinth East in Williamson County, was discovered in

Illinois during April according to the Geological Survey Division of the Department of Registration and Education. Corinth East is the second new pool to be discovered in Williamson County in 1957, the first being Corinth North discovered in February. The county had had no previous commercial production.

In addition to the one new pool, there were eight extensions to pools; two to Goldengate North Consolidated in Wayne County and one each to Sorento Consolidated in Bond County, Inman West Consolidated in Gallatin County, Dale Consolidated in Hamilton County, Clay City Consolidated in Jasper County, Reservoir in Jefferson County, and Dundas East in Richland County.

A total of 178 wells were completed in Illinois in April 1957 an average of about 45 per week in comparison 80 per week in April 1956. Of the 178 wells 65 are oil wells and 2 are gas wells, or 38 per cent successful, as compared with the usual 56 to 60 per cent successful. Drilling activity is widespread in the state. There is no area of concentrated development.

Production has fallen off slightly, but is holding up remarkably well considering the big drop in number of new producing wells being completed. The increase in amount of oil being produced by secondary recovery methods accounts for the nearly stable production rate. Production for April is estimated to be 6,833,000 bbl.

LOUISIANA

SOUTH LOUISIANA

Fifth Reservoir Produces In New Ridge Discovery

Another reservoir is proving productive in Lafayette Parish's Ridge field. It is the fifth for the area, opened by Sunray Mid-Continent Oil Co. and Warren Petroleum Corp. in November 1955. All produce gas and condensate.

The new pay is in the operators' 2 Trahan, a location north of the discovery well (1 Trahan). It is the fifth for the area so far. All were logged in the discovery well. They range in depth from 10,130 to 12,175 ft.

Production in 2 Trahan is from perforations at 11,007-33 ft. Flow through 15/64-in. choke was at the daily rate of 2,600,000 cu. ft. of gas per day.

The well, drilled to 11,676 ft., has been standing as "temporarily abandoned" since June of last year. No tests had been made at that time.

The Ridge area is in the southwestern part of the parish, only a short distance south of the same operators' older and large Duson field.

Breton Sound Discovery Opens New Oil Production

The California Co. has a new oil-discovery well in Breton Sound, off the east side of Plaquemines Parish's delta peninsula. It is in Block 58, Main Pass area, about 2½ miles southeast of two oil producers completed by the same company earlier this year in Block 41, and about 3 miles southwest of a relatively shallow gas well the same company completed the middle of last year in Block 40. It is about 10 miles offshore.

The new well was drilled to 9,004 ft. but is productive from casing-perforated interval at 6,848-52 ft. Tested through 9/64-in. in choke, it flowed at a daily rate of 174 bbl. per day with pressure of 525 psi. Gravity of the oil is 23.1°.

California Co.'s discovery well in Block 41 produces from perforated interval at 7,071-7,115 ft. Its confirming well is perforated at 7,398-7,415 ft. Pay of the dry gas well in Block 40 is perforated at 3,478-88 ft.

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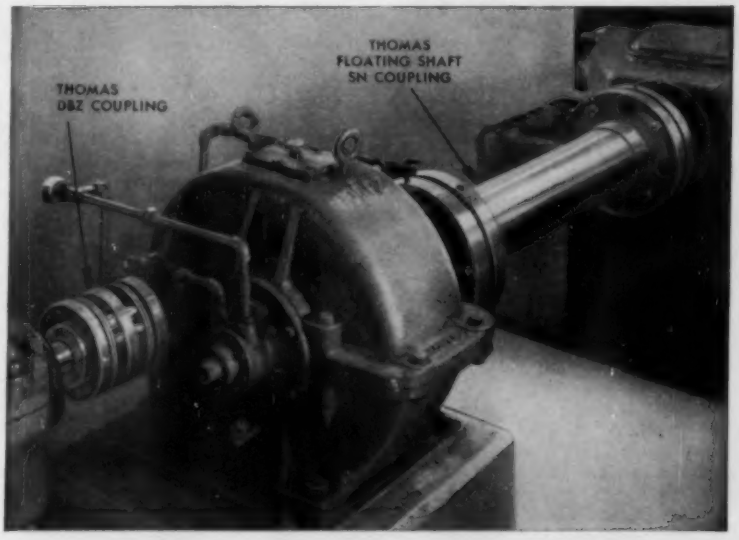

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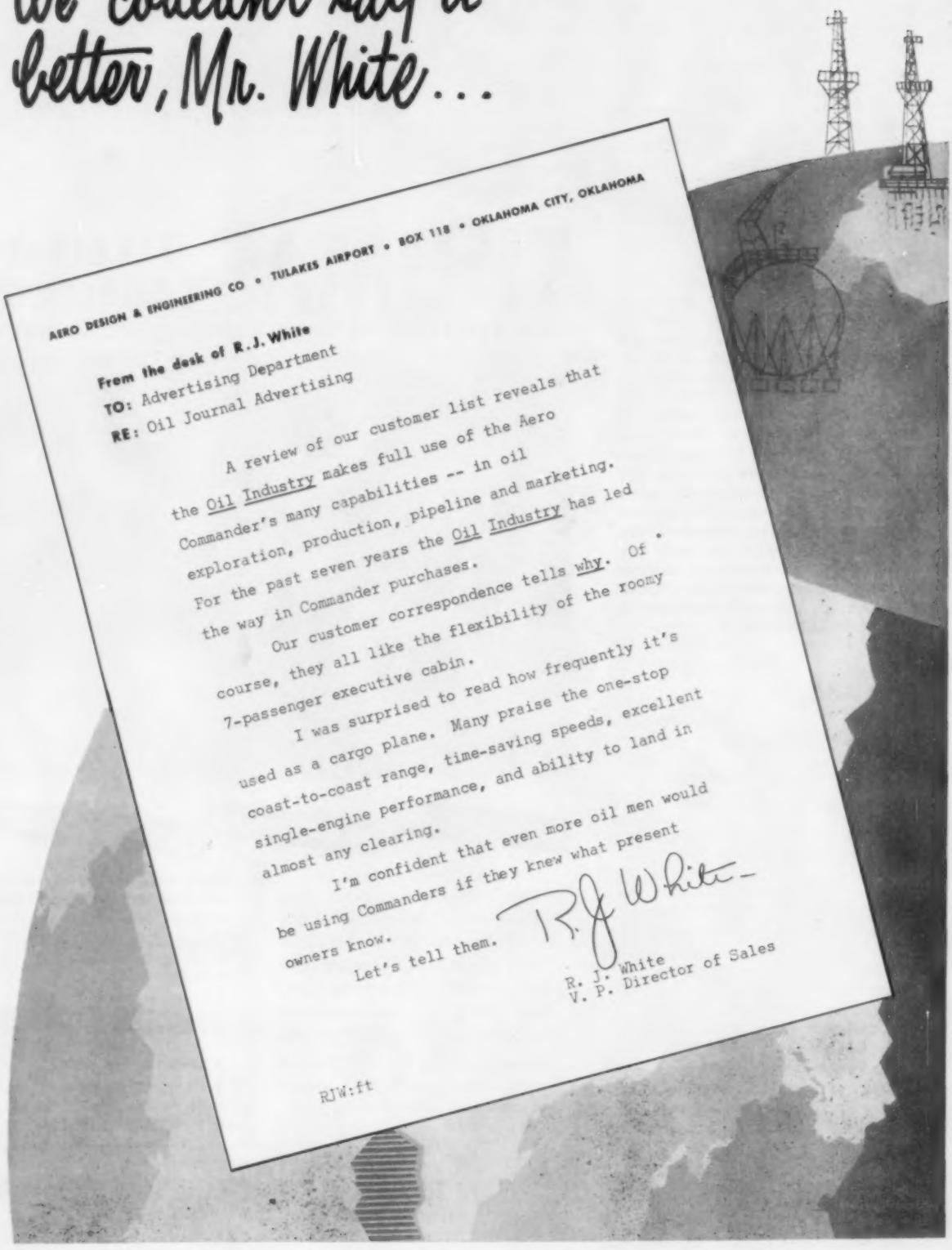

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From the desk of R. J. White

TO: Advertising Department

RE: Oil Journal Advertising

A review of our customer list reveals that the Oil Industry makes full use of the Aero Commander's many capabilities -- in oil exploration, production, pipeline and marketing. For the past seven years the Oil Industry has led the way in Commander purchases.

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I was surprised to read how frequently it's used as a cargo plane. Many praise the one-stop coast-to-coast range, time-saving speeds, excellent single-engine performance, and ability to land in almost any clearing.

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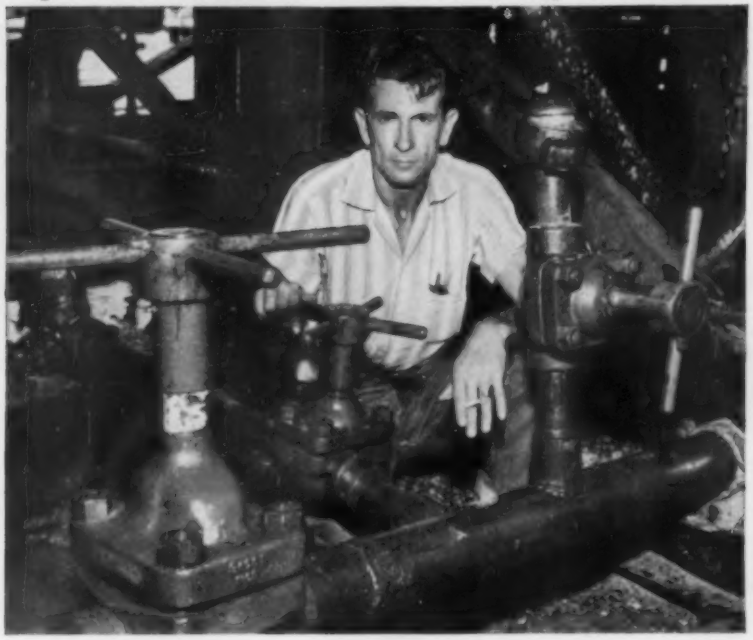
Tips on Mud Valves for Toolpushers . .



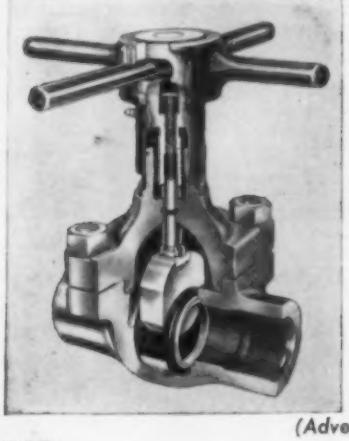
Bob Walker stops to look over a few of the MUDWONDER mud valves during rigging.

Veteran Oil Drillers Agree On MUDWONDER For Mud Valve Economy

By Robert Walker, Toolpusher, Rig #2
J. & B. Drilling Company, Eunice, Louisiana

WHEN your crew swears one mud valve is the best and the price tag is in line with other valves, logic says buy them. And, that's just what we did.

MUDWONDER cut-away view shows the double thread construction, separated stainless stem and hard chromed gate with "T" slot connection and the one-piece seat insert with the buna-N molded integrally over the steel wear rings.



Rockwell-Built MUDWONDER valves were put on all mudlines when the new "76" was rigged recently.

Past experience had proven the MUDWONDER valves as near trouble-free as a mud valve can be. So, it wasn't a difficult choice. Our vice-president, C. E. Bush, a veteran well digger, agreed that in sharply competitive contracting, J. & B. could not afford inferior valves.

The easy MUDWONDER operation, even at high pressures, and the long service life make it truly an "economy" valve. On the rare occasions when maintenance or inspections—even part replacements—are required, no drilling time need be lost. Mud valve work can be done while the crew makes a connection because the one-piece body stays in the line.

Two-inch and 4-inch MUDWONDER valves are being sent on our standpipe, mud guns, manifold, bleed-off, etc., with great success. Mr. Bush and the crew join in recommending MUDWONDER to any toolpusher having mud valve problems.

MUDWONDER valves are built in 2", 3", and 4" sizes with screwed or flanged ends for 2000 psi WP (4000 psi test) and 3000 psi WP (6000 psi test).

Your favorite oil field supply store can give you complete information or write Edward Valves, Inc., East Chicago, Ind.

(Advertisement)

Erath Extension Well Is Dual-Zone Gasser

Gas production is being opened in a wildcat drilled by Pan American Petroleum Co. off the north side of the large Erath field, southeast of Abbeville, in eastern Vermilion Parish. It is about a mile from production.

Pan American's discovery is in its 1 Alifau Broussard, in 43-13s-4e. The well was drilled to 13,500 ft. Production is from two zones. The lower pay is perforated at 12,738-48 ft.; the upper at 12,278-88 ft.

Flow from the lower zone, tested through ¼-in. choke, was at the rate of 2,070,000 cu. ft. of gas per day. Liquid recovery was 31 bbl. It was 52°-gravity condensate. Flowing pressure was 1,650 psi.

The upper zone tested 2,700,000 cu. ft. of gas and 35.5 bbl. of 49.6°-gravity condensate per day through ⅝-in. choke. Its flowing pressure was 3,950 psi.

Deeper Pay Produces In Third Well at Montegut

A slightly deeper sand is being found productive in the third well for the new Montegut field, 16 miles southeast of Houma, in Terrebonne Parish.

It is in Southern Natural Gas Co.'s 3 South Shore, 2,000 ft. south of the discovery well, drilled by the same company and completed last February.

The pay is perforated at 12,326-40 ft. Production through ⅛-in. choke was at the daily rate of 220 bbl. of 32.8°-gravity oil with gas-oil ratio of 796 cu. ft. per bbl. Flowing pressure was 2,300 psi.

The discovery well is productive of gas and condensate from a shallower reservoir, perforated at 12,179-84 ft. The area's second well, completed early this month, produces 34.7°-gravity oil from perforations at 12,190-92 ft. The latter well, 1-A Waterford, is a northeast offset to the discovery producer.

The area is 2 miles north of the large Lirette gas field, discovered in 1937.

MICHIGAN

Third Alpena Well Takes Test

Third successful Alpena Traverse oil producer in Edmore field east extension area was under test this week, good for as much as 50 bbl. of oil an hour. New well, E. Edwin Brehm, W. L. Harvey and Arthur Scribner 1 L. Peterson, SW SE SW 2-12n-6w, Home Township, Montcalm County, logged pay zone at 3,084-93 ft. where

THOMPSON
SAND RESISTANCE
OIL WELL PUMPS

TRAVELING PLUNGER ROD TYPE BOTTOM HOLD-DOWN PUMP STANDARD SIZE

Figs. 400P, 600P, 700P, 800P

Single or double, self-aligning, combination cup and plunger or all-metal traveling plunger type pumps made in four sizes: regular 1½", 1¾" oversize, 2" regular and 2⅛" oversize bore. These pumps seat in API seating device. In very sandy wells, or when tubing is out, we recommend our SAND HOUSING MECHANICAL SEATING SHOE, which prevents sanding in of pumps as sand can be dumped and the pump pulled at any time by our sand flushing arrangement.

TOP HOLD DOWN INSERT ROD PUMP

Standard Size, Figs. 400T, 500T

Self-aligning double plunger insert pumps. Made in three types: combination cup and single plunger; combination cup and double self-aligning type; and metal-to-metal double plunger self-aligning type. All are equipped with Regular or Extra Long Alloy Plungers, ground individually to fit the barrels, assuring longer life on both pump and surface equipment.

SELF-ALIGNING SAND SEALED-OFF PUMPS

Figs. 600-800-900

Inverted Combination Single or Double Plunger Self-Aligning Pumps can be equipped with a Sand Flush Valve which seals the Plunger off on top and cleans the barrel every pump stroke.

Sand is deposited into blind cage above the plunger and is discharged every stroke of the pump. The bottom of plunger is sealed to eliminate slippage. Easy on surface equipment. Lower lifting cost with Sealed-Off Pumps.

Can be run in any API seating device or use an adapter to fit the seating device preferred. We carry in stock at all times Special Heavy Duty Sand Housing Mechanical Seating Shoes which are very important to bad sand conditions—a place for sand to settle, so when pump is on down stroke, the bottom barrel bushing with a double spiral spray reaches into the sand housing, moving the sand out into the tubing.

SPECIAL HEAVY DUTY SEATING DEVICE

This special Combination Sand Housing and Seating Device is invaluable in bad sand conditions, especially where pump is sanding into the tubing. In extremely sandy wells the pump may be unseated occasionally to allow a small portion of tubing fluid to flush through the sand housing and return the accumulated sand to the well.

Pumps for all fields, depths and conditions. For further information write for complete catalog.

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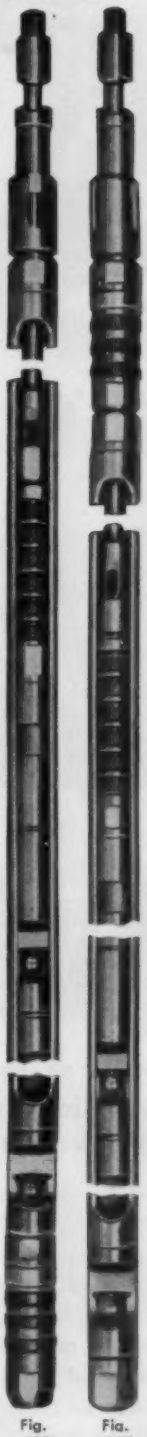

Fig. 400P 600P 700P 800P

Fig. 400T 500T

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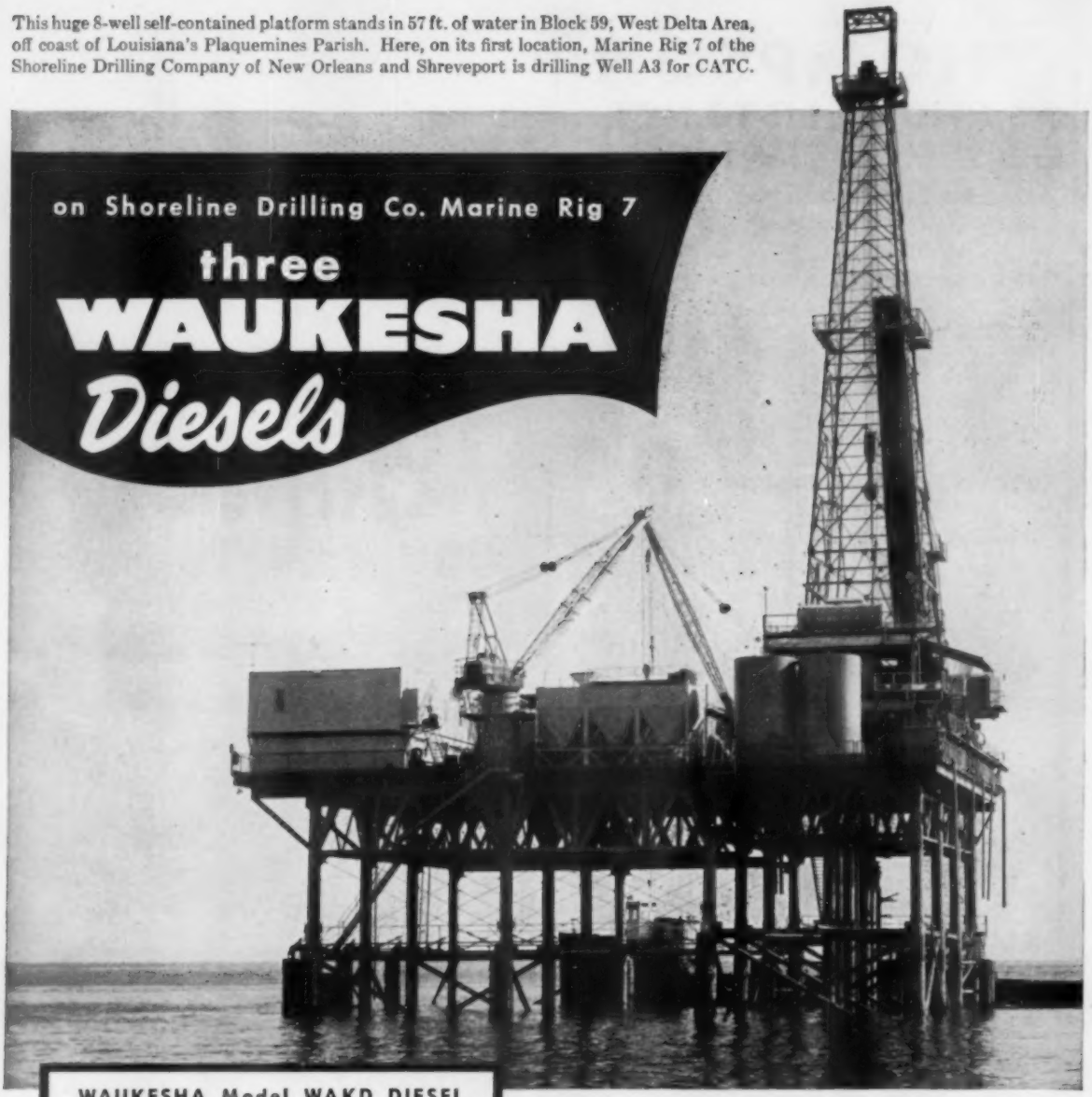
This huge 8-well self-contained platform stands in 57 ft. of water in Block 59, West Delta Area, off coast of Louisiana's Plaquemines Parish. Here, on its first location, Marine Rig 7 of the Shoreline Drilling Company of New Orleans and Shreveport is drilling Well A3 for CATC.



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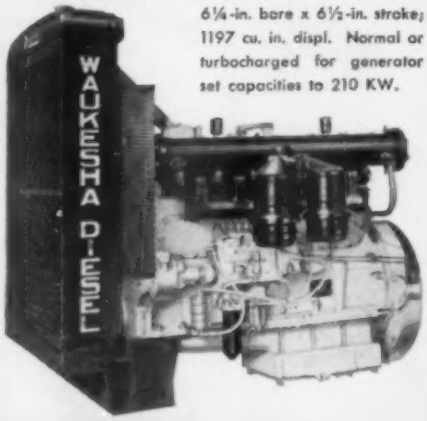

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each of the three 100 KW auxiliary power plants has its Waukesha WAKD Diesel

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WAUKESHA Engines and Power Units: 10 hp to 1135 hp—LP Gas • Natural Gas • Normal and Turbocharged Diesels—Get Bulletin 1079

gas was gaged at 1,200,000 cu. ft. a day and oil flowed at a restricted rate of 12 bbl. an hour. On a 15 hour restricted flow test well flowed 176 bbl. The 1 L. Peterson is the diagonal northeast 20-acre offset to extension producer and northwest offset to second successful producer in the area, all drilled by these same operators.

● The Taggart Co. established the south-southeast edge of Overisel Salina gas pool with the completion of two dry holes, one in the northeast quarter and the other in the northwest quarter, Section 34-4n-14w, Overisel Township, Allegan County.

To date Taggart has drilled 21 gas producers and these two failures, all on 160-acre well spacing pattern in this new southwest Michigan gas pool. Four complete sections have been proved productive, Sections 9, 15, 22 and 27-4n-14w, along with the west half Section 15, east half Section 21 and northeast quarter Section 28-4n-14w. Pool, as now developed is 4 miles long north and south, and 1½ miles wide at widest point.

● New Traverse oil test located ½ mile west by north of the old Woodville Oil pool, Newago County, was completed good for 150 bbl. of oil a day, restricted flow, with no water showing at John B. Cutter 1 Navarre et al, S½ SE SW 20-15n-11w, Norwich Township. Traverse lime top was logged at 2,846 ft. Pay showed between 2,850-51 ft., total depth.

● Aurora Gasoline Co. and McClure Oil Co. 1 Rowe, SE NW NE 10-5s-3w Scipio Township, Hillsdale County, was being flowed at a restricted rate of 120 bbl. of oil a day from Trenton oil pay at 3,929 ft., total depth. Well was pinched to an 18/64-in. choke opening.

NEW MEXICO

SAN JUAN BASIN

Gallup Producer Finaled in San Juan

Sunray Mid-Continent Oil Co. and partner have completed the 2 Es-Ka-Nel-E-Wood as a gas producer in 22-25n-11w, San Juan County, New Mexico.

The well produced 4,500 M.c.f. of gas a day from the Gallup zone. Perforations were made at intervals from 4,923-60 ft.

Oil Flows From Dakota At Deep Fulcher Test

A deep wildcat inside Fulcher-Kutz gas field in San Juan County flowed oil at the estimated rate of 150 bbl.

Canada uncorks its gas resources

For Canada's vast, almost untouched supply of natural gas, outlets have already been planned to deliver over 10 trillion cubic feet to North American markets. Canadian gas reserves are expected by 1970 to approach 55 trillion cubic feet.

To bring this fuel to millions of future consumers, the great Trans-Canada gas line is designed to span the 2250 miles from Alberta to Ontario. Westcoast Transmission lines will carry British Columbian gas to the U. S. Pacific Northwest. A network of complementary lines will blanket Western Canada's fields. All this at a cost close to $600 millions by 1959.

The Canadian Bank of Commerce maintains a complete Petroleum and Natural Gas Department in Calgary, and more than 270 branches throughout Western Canada. For information on any aspect of the industry in Canada, write or telegraph to C. H. Munro, Manager, Petroleum and Natural Gas Department, 309 Eighth Avenue, West, Calgary, Alberta.

(*We regret that we cannot advise on the merits of oil or mining securities.*)

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in the first 24 hours and 180 in the second. The well is McRae Oil & Gas Co. 1 Federal in SW NE NE 28-28n-10w. Production is from the Dakota sand from 6,644 to 6,672 ft.

There are just a few Dakota wells in this field, a Pictured Cliffs sand producer at a shallow 2,500 ft.

SOUTHEAST NEW MEXICO

Ellenburger Is Fourth Pay In Tidewater Wildcat

Tidewater Oil Co. 6 Coates-Federal "C," exploratory well in the Justice-Paddock field of southeastern Lea County, flowed oil from the Ellenburger, its fourth prospective pay zone.

No. 6 Coates drilled into the Ellenburger at 7,734 ft. on derrick floor elevation of 3,053 ft. On drill-stem test at 7,734-84 ft., gas surfaced in 4 minutes, mud in 14 and oil in 17 minutes. The first hour it gaged 51 bbl. of 39° oil. Flowing pressure ranged from 820-1,580 psi.; 30-minute shut-in pressure was 3,195 psi. The well was cored ahead after the test.

Location is in 24-25s-37e. Nearest Ellenburger production is 4 miles northeast in Dollarhide field. Other indicated pays are the McKee, Tubb, and lower Clear Fork.

Phillips Petroleum Co. 1 Austin, wildcat 5½ miles northwest of Caudill field in 17-14s-36e, apparently has given up the Devonian. Operators have plugged back from total depth of 14,796 ft. to 13,290 ft. for testing. Perforations in the Pennsylvanian at 10,974-11,012 ft. returned only load and sulfur water when swabbed.

The Texas Co. 1 Muse-Federal, 7-20s-33e, moved the rotary off and was shut in. Total depth was 15,560 ft. Last reported perforations were in the Delaware sand at 7,118-28 and 7,140-60 ft. Operators were fracturing and acidizing at this report.

Eddy County . . . Humble Oil & Refining Co. 2 Huapache, Ellenburger wildcat 7 miles northeast of Lincoln, has been plugged back to 8,360 ft. from total depth of 12,582 ft.

Shell Oil Co. 1 James Ranch Unit, deep wildcat in 36-22s-30e, was drilling limestone at 13,282 ft.

TEXAS

SOUTHWEST TEXAS

Deep-Edwards Production Moves Into Karnes County

Pre-potential tests of Gulf Oil Corp.'s deep-Edwards discovery well in the Fashing area on the Atascosa-Karnes

DEEP-EDWARDS discoveries in Fashing area on Atascosa-Karnes county line. Shown are Gulf Oil Corp. and others' newly completed discovery (A) in Karnes County, and Lone Star Producing Co.'s 1956 discovery (B) in Atascosa County.

county line rate the well good for 2,340,000 cu. ft. of gas daily, flowing through small chokes.

With that flow, liquid recovery is 55.7 bbl. daily. Gas-distillate ratio figures 42,000 cu. ft. per bbl. Liquid is a water-white 52.6°-gravity condensate. Flowing pressure is 3,708 psi.

The well, 1 Laskowski, is perforated at 10,794-10,836 ft., opposite the Edwards pay, after plugging back from drilled depth of 11,326 ft. in the Glen Rose section.

It was drilled by Christie, Mitchell & Mitchell, of Houston, with C. C. Winn and Milton V. Spencer, of San Antonio, and Gulf Oil Corp. having operating interests. Gulf assumed operation after final casing-string was run to complete the well.

Location is on the Karnes County side of the line about 3 miles northeast of deep Edwards gas-condensate production discovered last year by Lone Star Producing Co. north of the shallow Fashing field in southeastern Atascosa County. It is the most northeasterly location so far at which the deep-Edwards trend has produced.

NORTH TEXAS

Strawn Sand is Productive In Knox County Wells

Katz Oil Co., Abilene, 1 John M. Wylie et al., in southwestern Knox County, made a heavy flow of oil from Strawn sand. Successful drill-stem tests covered a 25-ft. section.

On drill-stem test at 4,862-86 ft., open 55 minutes, gas surfaced in 5 minutes and oil in 52. The well apparently did not flow but unloaded a full string of oil while pulling tubing. Bottomhole flowing pressure reached 1,125 psi.

After drilling to 5,200 ft., total depth, hole was plugged back to 4,917 ft. and casing perforated at 4,861-67 ft. The well flowed 110.6 bbl. of oil in 24 hours after acid treatment, with no water. Flow was through 18/64-in. choke, under tubing pressure of 50 psi.

Location of the Strawn strike is 2 miles northwest of Knox City townsite and 1½ miles southwest of North Knox City (Tamehill) field, in Section 53, Block 2, D&W Survey.

Recompletion in Strawn . . . Grace-Schlittler Drilling Co., Jacksboro, has recompleted its 1 Allie F. Benedict as a Strawn reef discovery 1 mile northeast of Knox City townsite. The well is south of Knox City-Canyon field.

No. 1 Benedict, formerly R. Clay Underwood 1 Benedict, perforated and fractured the Strawn at 4,674-78 ft. Pumping potential was 85 bbl. of 39° oil a day, with gas-oil ratio of 250:1.

EAST TEXAS

New Try Scheduled For Collin County

Hill & Hill, Fort Worth, have staked location for an 8,500-ft. Ellenburger wildcat in northern Collin County. The well will be 1 Levi Carruth, located

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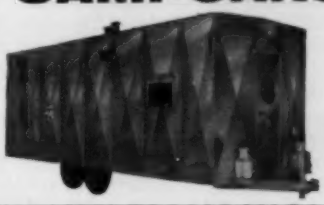

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660 ft. from south and east lines of a 123-acre tract in the John Cunningham Survey, which is 6 miles west of Anna and 1 mile east of Weston.

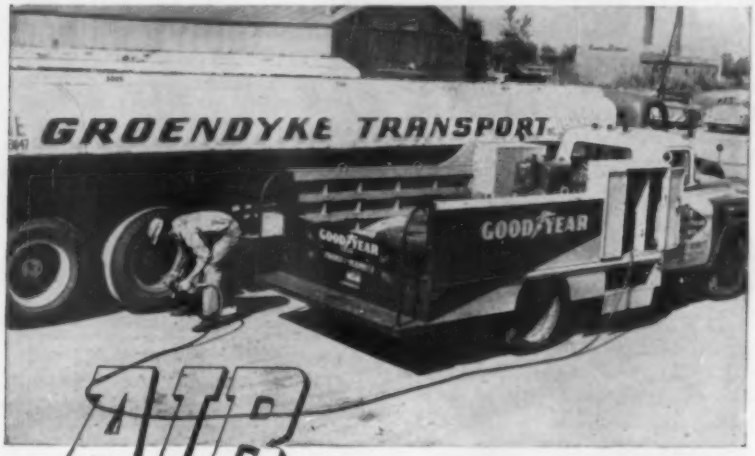
Subsurface control is furnished by Humble Oil & Refining Co.'s recent dry hole at 1 John Webster, 2 miles to the southwest of Hill & Hill's location, in the A. J. Culwell Survey. Humble's well found the Ellenburger at 6,830 ft. on elevation of 710 ft., and was drilled to 7,850 ft., total depth.

Bethel dome test . . . The Texas Co. has scheduled an 11,500-ft. wildcat for the west flank of Bethel salt dome in Anderson County. The test will be 1 E. C. Walton, located on a 48-acre tract in T. H. Kingsley League, A-1450, Juan N. Acosta Survey, A-1. Projected depth is expected to penetrate the Travis Peak.

Drillsite is ½ mile southwest of Woodbine oil production in Bethel field and 7 miles northwest of Tennessee Colony townsite.

In southern Anderson County Texkan Oil Co. 1 Wallace rated a daily potential of 2,000 M.c.f. of gas a day, plus 50 bbl. of condensate. Pay was the Woodbine at 5,867-76 ft.

Location of 1 Wallace is in the E. Austin Survey, 3 miles south of Slocum, between South Slocum-Woodbine and David Gail-sub-Clarksville fields.



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WEST TEXAS

Walker Field Gets Flowing Pennsylvanian Discovery

Tidewater Oil Co. 1-B White & Baker, surrounded by shallow Permian producers in the Walker field of Pecos County, made a heavy flow of oil while drill-stem testing in the Pennsylvanian.

Tidewater's 1-B White & Baker, Pennsylvanian discovery, is located in the shallow Walker area in Crockett County. A small area in the White & Baker area of this field also produces from the Pennsylvanian.

Operators drilled into the Pennsylvanian at 6,720 ft. on elevation of 3,066 ft. and tested at 7,230-7,375 ft. Oil surfaced in 2 hours and 45 minutes, at an estimated 40 bbl. an hour rate. Further tests at 7,349-75 and 7,374-7,430 ft. recovered mud with no shows. Drilling continued ahead below 7,493 ft., on contract depth of 10,500 ft.

Location is 17 miles west of Iraan, in Section 87, Block 194, GC&SF Survey.

Crane County . . . TXL Oil Corp. 1-AT Crane fee, deep wildcat in northeastern Crane County, recovered 3,180 ft. of oil and 333 ft. of oil and gas-cut mud while drill-stem testing the Ellenburger at 11,855-11,945 ft. The test was open 6 hours and 45 minutes. Flowing pressure ranged from 210-770 psi., and shut-in pressure read 1,285 psi. Operators prepared to drill ahead toward scheduled depth of 12,300 ft. Location is in Section 17, Block 43, T4S, T&P Survey, ½ mile west of Gulf Oil Corp.'s Connell discovery, 1 mile northwest of a 12,350-ft. dry hole and 3 miles east of Waddell field.

Gulf Oil 1 Adams, Permo-Pennsylvanian discovery 11 miles northwest of Crane, continued flow tests on perforations at 7,710-60 ft. After acid

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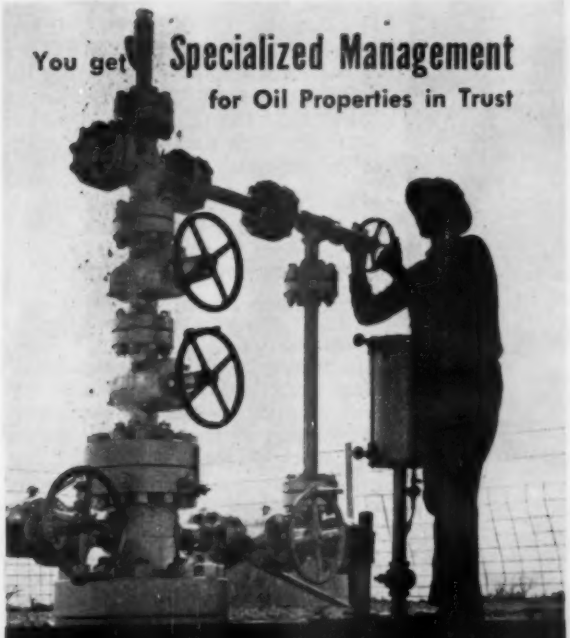

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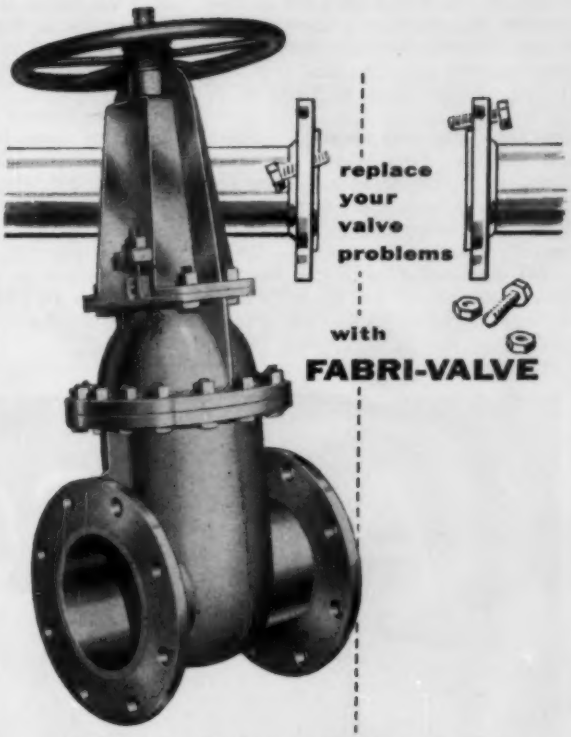

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treatment, the well kicked off to flow 507 bbl. of new oil in 15 hours through ½ and 15/64-in. chokes. Tubing pressure was 940 psi. This was a 11,400-ft. test, plugged back to 7,802 ft.

Howard County reef opener . . . Woodson Oil Co., Fort Worth, has completed its 1 Pauline as a Canyon reef discovery. Location is in Section 57, Block 20, Lavaca Navigation Co. Survey, 22 miles northeast of Big Spring.

On completion potential the well flowed 498 bbl. of 44° oil in 10 hours through 18/64-in. choke, for a calculated daily rate of 1,195 bbl. Gas-oil ratio was 897:1. Production was from perforations at 7,448-63 and 7,467-70 ft. Top of the reef was 7,444 ft. on elevation of 2,355 ft.

Yoakum County . . . Pan American Petroleum Corp. 1 West has been completed as a Devonian discovery. Potential was 295 bbl. of 40° oil a day through 7/64-in. choke, from perforations at 11,058-77 ft. Tubing pressure was 580 psi.

Location is in the SW SW Section 606, Block D, John H. Gibson Survey, 2 miles northwest of Wasson-San Andres field.

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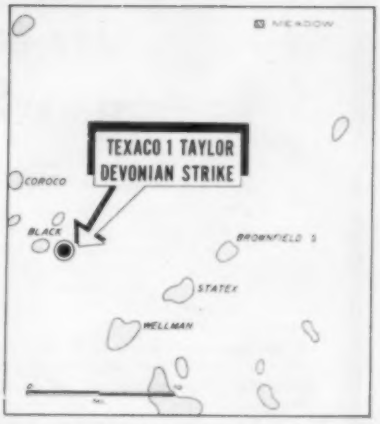

Terry County Devonian discovery. The Texas Co. 1 Taylor flowed 238 bbl. of 35° oil through 23/64-in. choke on potential test. Pay perforations were from 12,759-69 ft. Nearby Black field also has production in the Devonian.

Terrell County deep test . . . Southern West Texas gained a 15,000-ft. exploratory well at Magnolia Petroleum Co. 1 Brown Bassett, in northeastern Terrell County. Location is 2 miles west of Good (gas) field, in Section 218, Block Y, TCRR Survey. According to drilling maps, its geological location is either in the extreme southeastern tip of the Sheffield Channel, or along the western flank of the Val Verde basin.

Sheffield Channel wildcat . . . Phillips Petroleum Co. has staked location for an 18,000-ft. Ellenburger wildcat in central Pecos County. The test will be drilled as 1 Harral "A" in Section 6, Block 126, T&STL Survey. Nearest production is in Puckett field, 5 miles to the southeast.

TEXAS PANHANDLE

Lipscomb Records Fourth Producing Area

The fourth field in Lipscomb County was opened by Pan American Petroleum Corp. last week. The discovery well is 1 C. C. Duke in the northeastern part of the county in Section 781, Block 43, H&TC Survey.

The well was completed flowing 4,500 M.c.f. per day from perforations at 6,611-15 ft. in the Tonkawa sand-Pennsylvanian. Location of this new field is 5 miles northeast of the town of Lipscomb.

Upper Morrow Gas Well Finaled in Hansford

Horizon Oil & Gas Co. 1 George Buzzard, Section 144, Block 4-T, T&NO Survey, is a new upper Morrow-Pennsylvanian producing area in

Hansford County, 4 miles southeast of Spearman.

The well flowed 34,000 M.c.f. of gas daily plus 9 bbl. of distillate per million from perforations at 7,550-81 ft. and 7,599-7,605 ft.

● Another wildcat in Hansford County flowed 10,000-20,000 M.c.f. of gas per day from perforations in the Cleveland sand at 6,048-58 ft. This one is Roy Furr 1 Furr-Southland-Edwards, 12 miles southwest of Spearman and 8¼ miles southeast of Prairie field. Location is in Section 191, Block 45, H&TC Survey.

First Producer in Palo Duro Basin Completed

Shell Oil Co. has officially opened first oil production in the Palo Duro basin of the Texas Panhandle, the last of the three basins in this region to get oil production.

The 1 Alamosa Ranch, 13 miles northwest of Vega in Oldham County, flowed at the rate of 480 bbl. of oil per day from perforations in the Pennsylvanian at 6,101-23 ft. Gravity is 40°. Plugged back total depth is 6,169 ft.

East Extension to North Hansford Completed

Sunray Mid-Continent Oil Co. has completed the 8 Sanders as an east extension to North Hansford field in Hansford County, Texas.

The well flowed 252 bbl. of oil a day through a 24/64-in. choke from the Hepler sand. Perforations were made at 6,286-94 ft. Total depth is 6,735 ft.

The well is located in Section 94, Block 45, H&TC Survey.

Successful Wildcats

ALBERTA

Imperial-Canadian Superior 1-5 Vulcan, LSD 1, 5-18-23w4. TD 6,032 ft. Blairmore oil well.

L. B. Oils 1 Entwhistle, LSD 1, 11-54-7w5. TD 7,086 ft. Indicated D2 oil well.

Canadian Northern Pacific 15 South Pouce Coupe, LSD 7, 6-78-11w6. TD 5,172 ft. gas well.

BRITISH COLUMBIA

Pacific 85 Fort St. John, LSD 4, 24-86-20w6. TD 6,619 ft. Permo-Penn gas well.

Hudsons Bay 1 Milligan Creek, 57 degrees 08 minutes, 48.93 seconds West Longitude, 120 degrees 39 minutes 16.10 seconds North Latitude. TD 3,800 ft. Triassic oil well.

CALIFORNIA

Orange County: R. B. Watkins Operations 6 Deeble, SE SE 13-6s-11w, 97 BOPD, 26° gravity, 5 per cent cut, perfs. 5,420-5,600 ft. TD 6,960 ft. (New zone discovery on east flank of main West Newport field production).

Kern County: Richfield Oil Corp. 88-26 Mitchell, SE SE 26-11n-20w, 32 BOPD, 53.7° gravity, 0.5 per cent cut, perfs. 8,957-9,039 ft. TD 9,153 ft. (New pool discovery ¾ mile northwest of Windgap area of Wheeler Ridge field).

Kern County: Meridian Oil Co. 73A KCL, SE NE 10-29s-27e, 80 BOPD, 90 per cent cut, perfs. 3,305-22 ft., TD 3,325 ft. (New pool discovery 1 mile northeast of Fruitvale field production.)

COLORADO

Kiowa County: D. D. Harrington 1 Morse "A," C SE NW 28-20s-48w. IP 5,000 M.c.f. of gas per day, McClave discovery, new field. TD 4,987 ft. Mississippian.

Mesa County: Knapp Uranium Development Co. 1 Federal, SE SW SW 1-2n-3w. IP 2,500 M.c.f. of gas per day, Morrison discovery, new field. TD 2,395 ft. Salt Wash.

Kiowa County: D. D. Harrington 1 State A, C NE SW 34-19s-48w. IP 10,000 M.c.f. of gas per day, Morrow discovery, new field. TD 4,988 ft. Mississippian.

SOUTH LOUISIANA

Calcasieu Parish: Gulf Oil Corp. 1 Hebert et al gas unit, 8-11s-5w (1 mile northeast Hayes field). Shut-in gas well, no gage, perfs. 10,584-10,610 ft. TD 11,579 ft. (Extends Hayes field.)

Jefferson Davis Parish: Pan American Petroleum Corp. and Austral Oil & Exploration Co. 1 Henderson-Petitjean Unit, 24-11s-5w. Shut-in gas well, no gage. perfs. 12,120-28 ft. TD 15,532 ft. (New pay

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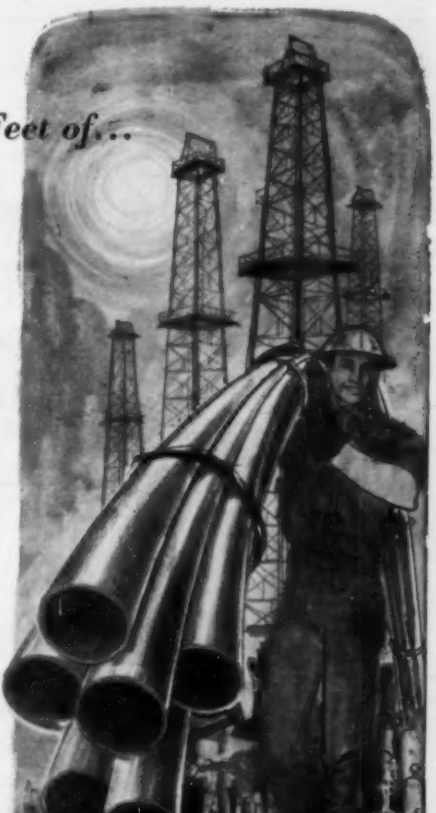

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and 1½-mile extension, South Thornwell field.)

Calcasieu Parish.: Signal Oil & Gas Co. 1 Greathouse, 9-11s-8w. IP 185 BOPD and 4,693 M.c.f. daily, 5/32-in., 49.8°, perforations 13,261-76 ft. TD 13,826 ft. (New pay and extension, South Lake Charles field.)

Cameron Parish: Warren Petroleum Corp. 1 Richard, 8-15s-6w (2 miles northwest of Hog Bayou field). IP 35 BOPD (net), 77 per cent b.s. & w., 1,350 M.c.f. daily, 5/32-in., 42°, perforations 11,406-16 ft. TD 11,485 ft. (New field.)

Iberia Parish: Berkshire Oil Co. 1 Berkshire-Jeanerette, 12-12s-10e. IP 65 BOPD, 2,700 M.c.f. daily, 11/64-in., 49°, perforations 12,183-88 ft. TD 12,315 ft. (New reservoir midway between Little Bayou Pigeon and Bayou Pigeon fields.)

Terrebonne Parish: The Texas Co. 1 Lake Barre Unit 38. Township 22s-19e, in Lake Barre off south flank of Lake Barre dome. IP 243 BOPD (net), 10 per cent b.s. & w., 2,369 M.c.f. daily, S-36 choke, 43.7°, perforations 16,303-26 ft. TD 16,573 ft. (New pay and extension, Lake Barre field.)

MICHIGAN

Midland County: Granville C. Berlin 1 Asakevich, SW SW SW 1-16n-2e. IPF 40 BOD, Dundee 3,366 ft., pay 3,450-52; 3,458-60 ft., TD 3,463 ft. (New pool.)

Roscommon County: Sun Oil Co. 5 Hogan Trustee, SE NE NE 17-22n-4w. IPP 56 BOD, Dundee 3,656 ft., pay 3,710-16 ft., TD 5,090 ft., PBTD 3,747 ft. (New pay—shallower—in Nellsville pool.)

NORTHWEST NEW MEXICO

Rio Arriba County: Northwest Production NE 1-16, SE NW SW 16-27n-2w. IP 938 M.c.f. of gas per day, Gallup discovery, new field. TD 7,368 ft. Gallup.

SOUTHEAST NEW MEXICO

Eddy County: Olen F. Featherstone 1 Featherstone-Crosby, 5-16s-30e. IP 240 BOPD, 36°, top pay 2,749 ft. TD 2,775 ft.

NEBRASKA

Banner County: Colorado Century et al 1 Grubbs, C SW SW 13-17n-56w. IPP 200 BOPD, "J" sand discovery, new field. TD 6,640 ft. Skull Creek.

PENNSYLVANIA

Indiana County, Armstrong Township: T. W. Phillips Gas & Oil Co. 5 G. W. Uncather, elevation 1,457 ft., 1,300,000 cu. ft. gas, after fracture, Tully 6,985 ft., Onondaga 7,550 ft., chert 7,568 ft., gas 7,718 ft. TD 7,750 ft.

Indiana County, Young Township: James Shearer 1 L. Azzelio, 400,000 cu. ft. gas after second fracture, Oriskany sand 7,682 ft., gas 7,692 ft. TD 7,692 ft.

TEXAS GULF COAST

Bee County: Dakamont Exploration Corp. 1 Kessler, Patrick Carroll Sur., A-12. IP 77.52 BOPD, ¼-in., 39.7°, perfs. 3,760-71 ft. (Hockley). TD 4,265 ft. (New pay in North Beeville field.)

Kenedy County: The Texas Co. 12 Yturria-NCT-1, San Jose de Carricitos Jose Narciso Cabazos Sur., A-8, Share 2. Shut-in gas well, no gage, perforations 4,037-43 ft. TD 4,394 ft. (New pay in Monte Pasture field)

Matagorda County: Brazos Oil & Gas Co. 1 Harrison et al, Section 25, Lewis Goodwin Sur., A-162. IP 42.51 BOPD, ⅛-in., 35.3°, perforations 9,052-64 ft. (Frio). TD 10,299 ft. (New reservoir ¾ mile northwest of Palacios field—discovery well of North Palacios field.)

Nueces County: Arkansas Fuel Oil Corp. et al 1 State Tract 905-S, Gulf of Mexico (8 miles southeast of Flour Bluff). IP 31,250 M.c.f. daily, open flow, perforations 8,207-13 ft. TD 12,250 ft. (New offshore field.)

Arkansas Fuel Oil Corp. et al 1 State Tract 904-S, Gulf of Mexico. IP 4,900 M.c.f. daily, GLR 50 M.c.f. per bbl., 49.6°, perforations 8,646-52 ft. and 8,662-78 ft., and (dual completion) 26,-800 M.c.f. daily, open flow, GLR 58.8 M.c.f. per bbl., 47.6°, perforations 9,038-52 ft. TD 9,371 ft. (New pays in G.O.M.-State 904-S field.)

SOUTHWEST TEXAS

Starr County: Shell Oil Co. 3-A Andres M. Garza-State, E. Rangel Sur. 218 (26 miles northeast of Rio Grande City). IP 157.68 BOPD, ⅛-in., 53°, GOR 613 cu. ft. per bbl., perforations 5,720-40 ft. (Frio), and (dual completion) 3,560 M.c.f. daily, ⅞-in., 26.2 BC per M.M.c.f., perforations 8,464-88 ft. (Vicksburg). TD 9,908 ft. (New pays in North Rincon field.)

Duval County: Oil Corp. 1 Atlee Parr, Blk. 21, Wheeler Splane Subd. (6 miles south of Benavides). IP 23,200 M.c.f. daily, open-flow potential, GLR 34.83 M.c.f. per barrel, 65.7°, perfs. 5,788-94 ft. (Pettus). TD 5,910 ft. (New field.)

NORTH TEXAS

Archer County: La Gorce Oil Co. 1 Foster, A. T. Akers Sur., A-922, 2½ mi. SE Archer City. IPP 75 BOPD, 42°, GOR 700, Caddo perforations 4,853-66 ft. TD 5,510 ft.

Knox County: Carter & Gifford 1-A Camp-

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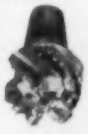

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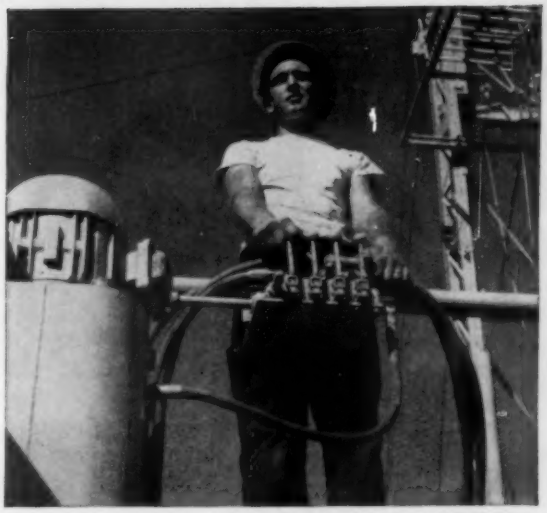

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bell, Blk. 99, J. A. Fanning Sur., A-31, 2½ mi. NW Knox City. IPP 70 BOPD, 36°, GOR 150, Tannehill 2,305-09 ft. TD 2,341 ft.

Wise County: Southern Union Gas Co. 1 Minnie Isbell, J. M. Mora Sur., A-541, 5 mi. SE Cottondale, SE of oil production. IP 64,400 M.c.f. of gas per day, conglomerate perforations 5,164-84 ft. TD 6,040 ft.

The Texas Co. 1 Thurman Womack, S. G. Evitts Sur., A-226, 2 mi. NW Boonsville. IP 4,165 M.c.f. gas per day, 28/64-in., CP 1,095 psi., conglomerate perforations 4,878-5,554 ft. TD 5,625 ft.

Young County: Kenneth J. Rich et al 1 M. K. Graham estate, Blk. 6, Sec. 2907, TE&L Sur., 15 mi. W Graham. IP 372 BOPD, 30/64-in., 41°, GOR 730, TP 410 psi., top Marble Falls conglomerate 4,206 ft. TD 4,211 ft.

WEST CENTRAL TEXAS

Brown County: H. A. Birdwell & Son Drilling Co. 3 Ella Muery, H. F. Adams Sur. 10, 5 mi. NW Bangs. IP 45 BOPD, 24/64-in., 43°, GOR 800, TP 40 psi., pay 1,221 ft. TD 1,265 ft.

Coleman County: T. G. Shaw 1 Patsy Morris, Sec. 67, Blk. 2, GH&H Sur., 7 mi. NW Coleman. IP 1,330 M.c.f. gas per day, 700 psi., Morris sand 2,656-66 ft. TD 3,303 ft.

Jones County: Dugger & Herring 2-C Herring, DeWitt CSL Sur., 8 mi. N Merkel. Recompleted as discovery. IP 103.7 BOPD, 16/64-in., 43°, GOR 875, TP 125 psi., pay 4,642-60 ft. TD 5,230 ft., PB 4,780 ft.

Fletcher Oil & Gas Drilling Corp. 2 Luna, Sec. 58, Blk. 18, T&P Sur., 9 mi. SW Anson. IP 74 BOPD, 12/64-in., 43°, GOR 420, TP 600 psi., pay 4,000-06 ft., TD 4,053 ft.

Stephens County: Brown - Walker - Casey & Weemple 1 Corbett, Sec. 1701, TE&L Sur., 3 mi. NE Ivan. IP 332 BOPD, 16/64-in., 42°, GOR 1350, TP 525 psi., conglomerate perforations 4,128-34 ft. TD 4,676 ft.

Haskell County: Stamford Royalties 1 Hendrick estate, A. Rodriquez Sur., Subd., g, 18 miles E Stamford. IP 264 BOPD, ½-in., 38°, GOR 500, TP 295 psi., pay 1,583-98 ft. TD 1,735 ft.

WEST TEXAS

Cochran County: Sun Oil Co. 1 Cynthia Malone estate, Sec. 321, Blk. 1-A, H&TC Sur., 10 mi. NW Robert Lee. IP 130 BOPD, ¼-in., 49°, GOR 1573, TP 1100 psi., Pennsylvanian 5,582-96 ft. TD 7,005 ft.

Reagan County: Virgil C. Moore 1 Lowery & Smith, Sec. 12, HE&WT Sur., 5 mi. N Big Lake. IPP 97 BOPD, 35°, GOR 350, Grayburg 2,668-74 ft. TD 2,744 ft.

Coke County: Plymouth Oil Co. 1 Tidwell, Thomas Shell Sur. 965½, 5 miles SE Robert Lee. IP 173 BOPD, 7/64-in., 42°, GOR 583, TP 550 psi., Ellenburger perfs. 6,120-50 ft. TD 6,666 ft.

Crane County: L. H. Armer 7 Ewell McKnight, 10-17-PSL, 11 miles SE Monahans. New pay. IP 120 BOPD, open 2-in., 36°, GOR 1200, Clear Fork 4,410-26 ft. TD 4,449 ft.

T. M. Evans 1-6 University, 6-31-University Lands, 12 miles NW Crane. IPP 140 BOPD, 36°, GOR 200, Pennsylvanian 8,212-42 ft. TD 11,800 ft.

Reeves County: Gulf Oil Corp. 1 Worsham, 10-C6-PSL, 12 miles SE Pecos. IP 17,000 M.c.f. gas, open flow, plus gas-liquid ratio 334,000:1, 61°, Delaware 5,030-80 ft. TD 8,500 ft., elev. 2,688 ft.

Runnels County: Carl Hoblitzelle 1 Lester Lee, Sec. 22, A-1293, H&GN, 3 miles SE Morton. IP 3,970 M.c.f. gas, Odom limestone 4,770-74 ft. TD 4,782 ft.

Tom Green County: British-American Oil Producing Co. 1 Cargile, 15-5-H&TC, 17 miles NE Mertzon. IP 484 BOPD, 22/64-in., 41°, GOR 196, TP 150 psi., Wolfcamp 5,684-94, 5,713-19 ft. TD 7,865 ft.

NORTH TEXAS

Clay County: General American Oil Co. 1 Brixey, Blk. 3, Halsell Subd. 1, 9 miles SW Henrietta. OWWO, previously completed in Caddo. Old TD 5,972 ft., perf. Ellenburger 5,954-61 ft., IPP 154 BOPD, 40°, GOR 350. TD 5,972 ft.

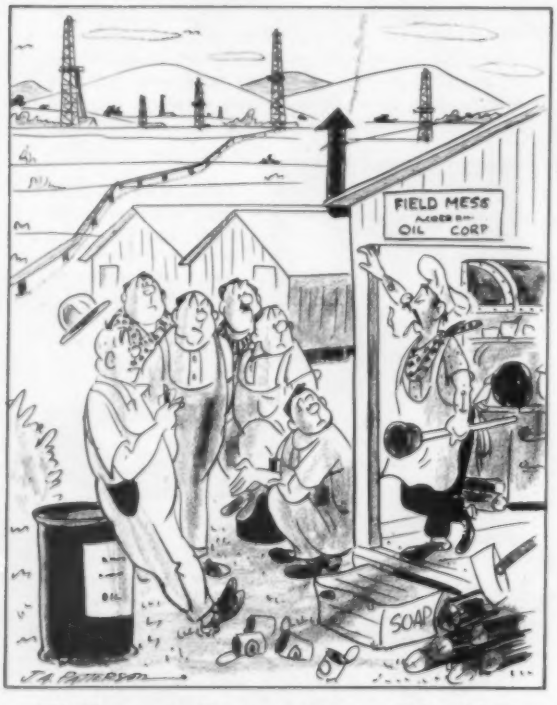
Wise County: Christie, Mitchell & Mitchell 1 Smith, Sec. 1, Falls CSL, A-293, 2 miles SW Park Springs. OWWO. IP 5,900 M.c.f. gas, plus 29 bbl. distillate, Atoka conglomerate 5,728-32, 5,758-74 ft. TD 5,900 ft.

UTAH

Uintah County: El Paso Natural Gas Co. 3 Unit, NE NE SE 15-10s-23e. IP 971 M.c.f. of gas per day, Mesaverde discovery, new field. TD 7,418 ft. Mesaverde.

WYOMING

Crook County: True Oil Co. B-6 Burrows, C NE NW 8-49n-68w. IPF 28 BOPH, -in choke, Minnelusa-Pennsylvanian discovery, new pay. TD 8,081 ft. Minnelusa.



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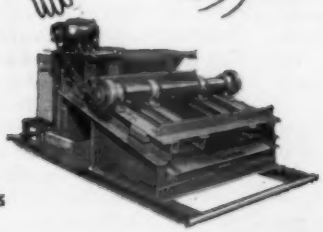
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. . . B.P.'s Gass Likes the Future

THE early months of 1957 "have been a difficult period in which we have experienced a reduction in our trade, and the growth of consumption in the European area has, for the present, slowed down."

These words, which could easily be regarded as just a bit of an understatement, came last week from the man who took over the helm of his company during what was probably the second greatest crisis to face it.

British Petroleum Co., Ltd., was probably as hard hit by the closing of the Suez Canal as any oil company in the world—perhaps the hardest hit of all of them. The man who made the comment was Neville Archibald Gass, the new chairman of B.P.

In almost the same breath in which he described B.P.'s "difficult period," Gass looked to the future and added, "But the basic facts of the world's growing energy requirements and the increasing contribution to be made by oil remain unchanged and we can look forward to an expanding business, granted stable conditions in the Middle East."

Tall, fresh-complexioned, with a mustache, Gass could be described as "typically English" in appearance. Genial in manner, he is known throughout B.P.'s organization both in England and abroad for his ability to recall names and faces. He has visited the group companies of the B.P. organization so often that he's a familiar figure throughout a good part of the world.

Gass became chairman of B.P. only 9 months after he was named deputy chairman. He stepped into the head office after ill health forced the premature retirement of B. R. Jackson less than a year after the latter succeeded Lord Strathalmond, longtime chairman of the company. Jackson died a little more than a month ago.

When the new chairman stepped into the top spot with B.P., he faced a problem that he has faced many times in his 38 years with the company—a troubled Middle East. The Middle East is his company's prime source of crude and Gass is well experienced in the pitfalls that go with depending on this area for oil.

Gass explained the gravity of this problem last week to his shareholders when he pointed out that during the 4 months preceding March 1, B.P. averaged only 600,000 bbl. daily from the Middle East. In the 4 months before that, the company got 950,000 bbl. daily, or almost 94 per cent of its average crude supply last year.

NEVILLE ARCHIBALD GASS
. . . expansion in Europe, Canada.

Born in 1893, Gass was educated at Tonbridge school in Kent, and at McGill University in Montreal. After a short stint in the office of European manager of the Canadian Pacific Railway Co., he left London for France and World War I service as an officer in the Royal Artillery. This won him the Military Cross and the Belgian Croix de Guerre.

Early career . . . By the end of the war, railroading had lost its charm for Gass and he joined Anglo-Persian Oil Co. (B.P.'s former corporate name) in 1919. He was sent to Iran and worked there in several capacities before becoming assistant general manager at Abadan in 1926. He became deputy general manager in 1930 and 4 years later was called back to the company's London office.

During his 15 years in Iran, Gass gained a twofold reputation. He was known as one of the foremost sportsmen in Iran, playing all field sports and starring in tennis and squash. Today he confines his sporting activities to golf.

During his stay in the Middle East—and for years after he returned to London—he represented B.P. in important negotiations with several governments in that area of the world. He numbers a great many individuals in the Middle East as well as in Europe and the United States among his wide circle of business contacts and friends.

Iranian crisis . . . It was this wide experience that enabled Gass to lend his talents to his company in the recovery period after the Iranian nationalization. This crisis was easily the greatest ever faced by the company because it lost its primary sphere of operation in one fell swoop. By the time the nationalization period ended 3 years later, B.P. was already beating its way back to its former spot in the world's oil picture, independently of Iran. Gass' ability to master the essential facts of complex problems and new problems and to do it quickly served his company well in this period. His abilities drew governmental attention. He was made a Commander of the Order of the British Empire (C.B.E.) in the Queen's Coronation Honors List of 1953.

Today, catapulted into the top position in his company, Gass leads B.P. into a new period of expansion following the Suez crisis. The future points to a large-scale expansion program for the company in Europe, widespread exploration for more sources of crude in a large part of the Eastern Hemisphere, and British Petroleum's entry into Canada as an integrated oil company.

Sol Meltzer, exploration geologist in Calgary for Canada-Cities Service Petroleum Corp., has been appointed district exploration geologist for western Alberta and British Columbia district. **Donald G. Wright,** Calgary geologist, has been named exploration geologist in the eastern Alberta, Saskatchewan, and Manitoba district. **Bernard J. Kelly,** also geologist with the company in Calgary, has been named district development geologist. Meltzer has been with Cities Service since 1950. Wright joined the company in 1950, and Kelly in 1952.

S. K. Van Steenbergh has been promoted by Sinclair Oil & Gas Co. from Houston division geophysicist to exploration superintendent in Houston. Van Steenbergh has been with Sinclair since 1942. He had been division geophysicist since 1954. **D. D. Goddard,** senior geophysicist in Houston since 1955, will succeed Van Steenbergh as Houston division geophysicist. Goddard joined the company in 1954.

Walter M. Lenamon, petroleum engineer with Magnolia Petroleum Co. in Vanderbilt, Tex., has been promoted to district petroleum engineer and transferred to Pampa, Tex.

New Panhandle Chapter of A.A.O.D.C. Elects First Officers

Heading up the first slate of officers for newly-formed Panhandle chapter of the American Association of Oilwell Drilling Contractors is E. E. Simmons, Cree Drilling Co., Pampa, Tex., chapter chairman, right. Other officers in picture, left to right, are Max E. Banks, Baker & Taylor, Amarillo, Tex., chapter vice chairman; D. E. Holt, Holt Brothers Drilling Co., Pampa, vice chairman; Jack H. Abernathy, Big Chief Drilling Co., Oklahoma City, president of national association; F. N. Hills, Hills & Hills Drilling Co., Pampa, vice chairman; and Simmons. A fourth vice chairman, C. N. Dunnam of Midwestern Drillers, Inc., Liberal, Kans., wasn't present.

William Klinger, western division manager for Frontier Refining Co., Denver, has been promoted to special products manager. **Noel Fletcher** succeeds Klinger as western division manager.

David H. Scott, formerly superintendent of exploration for Caltex, Ltd., in Australia, has joined Signal Oil & Gas Co. as chief geologist. **Harry A. Godde** has been appointed manager of Signal's offshore exploration department.

Norman T. Robey, assistant manager of the Casper, Wyo., refinery of Standard Oil Co. (Ind.), has been transferred to Whiting, Ind., as assistant refinery manager. **Del Vebo,** formerly in Whiting, has transferred to Casper to replace Robey.

C. S. MacGregor, manager of the utilities department at Shell Oil Co.'s Houston refinery, has been transferred to the company's Anacortes, Wash., refinery as assistant chief engineer-field. **E. J. Newton,** assistant chief engineer in Houston, will succeed MacGregor as ultilities-department manager. **W. G. Eddleman,** senior project engineer at Shell's Wood River, Ill., refinery, has moved up to assistant chief engineer at the Houston refinery replacing Newton. MacGregor has been with Shell since 1945. Newton joined the company in 1933 in Houston and Eddleman in 1946 at Wood River.

M. W. Sanderfer, tool pusher for Henderson Drilling Corp. since 1947, has been promoted to drilling superintendent.

J. H. Goatley, Shell Oil Co. reservoir engineer in Houston, has been transferred to Kilgore, Tex., as exploitation engineer.

John E. Swearingen, executive vice president of Standard Oil Co. (Ind.), has been named a director of American National Bank & Trust Co. of Chicago. He succeeds **Frank O. Prior,** Indiana Standard president, on the American National board.

Richard R. Newton has joined First National City Bank of New York's petroleum department as petroleum engineer. Newton was formerly a petroleum engineer with Smith Newton Oil Co. and with Continental Oil Co.

Dale Godfrey has been promoted to chief process engineer at the Ponca City, Okla., refinery of Cities Service Oil Co. He will also remain chief refinery chemist. **O. A. Pipkin,** foreman of the Rexformer unit at Ponca City, has been named head of the cracking department. **M. V. Stuewe,** cat cracker foreman, will succeed Pipkin at the Rexformer. **K. G. Venzke,** formerly in process engineering, has been appointed fluid catalytic cracking unit foreman, and **Everett S. Beran** has been appointed senior process engineer.

Personals

Riley V. Carlton has been transferred by Pan American Petroleum Corp. from Lubbock, Tex., to Fort Worth as petroleum engineer.

C. D. Gard, chief process engineer with Union Oil Co. in Los Angeles, will retire June 1. Gard has been with Union since 1921.

Charles W. Sternberg, consulting geologist, has opened offices in Marblehead, Mass., after completing an assignment through United Nations Technical Assistance as a petroleum exploration advisor to the Israeli Government.

W. H. Paulman, acting chief engineer of Shell Chemical Corp.'s Denver plant and formerly assistant chief engineer, has been named chief engineer. Paulman has been with Shell since 1946.

Orville S. Carpenter, president of Texas Eastern Transmission Corp., has been elected a director of the American Gas Association. He succeeds **George T. Naff,** vice chairman of Texas Eastern Transmission, who has resigned from the A.G.A. board.

G. K. Marple has been named mechanical superintendent at Atlantic Refining Co.'s Philadelphia refinery. He was formerly assistant superintendent of the mechanical department. Marple succeeds **W. O. Hoffman,** who was recently appointed general superintendent of the services division.

Joseph S. Bowman, vice president of Colorado Oil & Gas Corp., Denver, has been elected executive vice president. Bowman has been with Colorado Oil & Gas since 1954. He was formerly coordinator of oil activities for Lambert & Co., New York investment banking firm, and assistant to the president of Union Sulphur & Oil Corp. before that time.

S. Z. Natcher, president of Iran California Oil Co., Standard Oil Co. of California subsidiary, has been appointed manager of public relations for the parent company. Natcher was assistant manager of the public-relations department at one time. He succeeds G. Stewart Brown, who died recently.

Personals

L. F. McCollum, president of Continental Oil Co., has been elected for another 10-year term as president by Conoco stockholders. He became president of the company in 1947 under a 10-year contract. McCollum began his career in the oil industry with Standard Oil Co. (N. J.) and its affiliates. He rose to division geologist of Humble Oil & Refining Co. before transferring to Carter Oil Co. as exploration manager in 1934. He was later vice president and then president of Carter. He was coordinator of all Jersey Standard production activities when he accepted the presidency of Conoco.

Edward G. Casteel has joined Creole Petroleum Corp. as mechanical engineer in the pipeline department at Tia Juana, Venezuela. Casteel is a recent graduate of the University of Oklahoma.

C. R. C. Wijckerheld Bisdom has been nominated as a director of Royal Dutch Petroleum Co. to succeed **J. Klopper,** who has resigned. The new director will be elected at a May 29 meeting of Royal Dutch shareholders. Wijckerheld Bisdom is a member of the firm of DeBrauw, Wijckerheld Bisdom & Ter Kuile, legal counsels for Royal Dutch.

D. P. Stevenson, head of the chemical physics department at Shell Development Co.'s Emeryville, Calif., research center, has been promoted to associate director of research there. He succeeds **M. W. Tamele,** who was recently assigned to Shell Laboratories in Amsterdam. **J. W. Otvos,** assistant head of the chemical physics department, will replace Stevenson as department head.

Ben C. Adams, Jr., vice president and general manager of Gas Service Co., Kansas City, and **Jerry T. Duggan,** vice president and general counsel, have been elected directors of the company. Adams was vice president of the gas-supply department of Texas Gas Transmission Corp., and vice president in charge of operations for its subsidiary, Texas Gas Exploration Corp., before joining Gas Service Co. in 1955. Duggan joined the company in 1950 as general counsel. He was elected a vice president last year.

Robert A. Sanford has been appointed assistant director of the research division of Sinclair Research Laboratories, Inc.

Campbell M. Carothers, Humble Oil & Refining Co. assistant area petroleum engineer in Los Angeles, has been named assistant division petroleum engineer in New Orleans.

Joe E. Davis has been elected vice president and a director of Hondo Petroleum Corp. Davis was formerly vice president and division manager for Firestone Tire & Rubber Co.

William A. Green, executive vice president of MidSouth Gas Co., Little Rock, Ark., will retire June 1. Green has been with MidSouth and its predecessor companies since 1921. He will remain with the company as a consultant.

F. O. Koontz has been elected president and chief executive officer of Quaker State Oil Refining Corp. Koontz succeeds **Guy B. Hunter,** who has been appointed chairman of the board. As chairman, Hunter replaces **W. R. Reitz,** who remains a director.

F. T. Elliott, superintendent of Continental Oil Co.'s Abilene, Tex., production district, has been transferred to Hobbs, N. M., as district superintendent. Elliott will be succeeded at Abilene by **William A. Mead,** assistant production superintendent.

Walter I. Weed, Jr., operating assistant in Tidewater Oil Co.'s western oil purchase and exchange department, San Francisco, has been promoted to assistant supervisor of the department. Weed has been with Tidewater since 1952.

Grafton L. Jeter has been promoted by Magnolia Pipe Line Co. from assistant chief dispatcher to chief dispatcher, succeeding the late R. L. Council. Jeter joined the company in 1931 as operator-gager at the Simsboro pump station near Teague, Tex. He was transferred to Dallas as dispatcher in 1936 and was named assistant chief dispatcher in 1951.

Seven staff engineers have been given assignments at Tidewater Oil Co.'s new Delaware City, Del., refinery. They include: **William E. Baston,** reforming and extraction; **William H. Graf,** crude area; **Charles S. Joanedis,** desulfurizing and hydrogen; **Charles McCloud,** coking area; **Frank J. Menton,** alkylation-polymerization; **Robert E. O'Sullivan,** utilities and sulfur recovery; and **Joseph H. Schramm,** cracking area.

Alex W. Head, Houston independent, has been elected a director of Gulf Coast Leaseholds, Inc.

H. H. Loomis, geologist with Garfield & Pasternak in Denver, has resigned to open consulting offices there.

S. M. Boyer, geologist with Gulf Oil Corp. in Evansville, Ind., has joined Illinois Oil Co. in Lawrenceville, Ill.

J. S. (Cy) Young, administrative assistant in Amerada Petroleum Corp.'s production department, Tulsa, will retire June 1. Young has been with Amerada since 1924.

Charles E. Forrester, production engineer with Cities Service Oil Co. in Lafayette, La., has been promoted to marine engineer and transferred to Houston.

Allen F. Agnew has been appointed state geologist and director of the South Dakota Geological Survey. He succeeds **E. P. Rothrock,** who has resigned.

John F. Greene, Jr., has been named a vice president of California Crude Sales Co. in charge of foreign crude-oil sales. Greene was supervisor of operations for The California Co.'s supply and distribution division before California Crude Sales was formed in 1955.

E. H. COUNTS

E. H. Counts, Sinclair Oil & Gas Co.'s superintendent of operations in the gas and gas products department, Tulsa, has been promoted to staff general superintendent of the department. He succeeds the late J. L. Gallagher. A graduate of Oklahoma A.&M. College, Counts has been with Sinclair since 1933. He was named superintendent of gas products plants operations in 1953.

M. L. Barlow, California State Department of Education; **J. K. Kellogg,** K. L. Kellogg & Sons; **F. T. Lloyd,** Richfield Oil Corp.; **E. A. Plunkett,** National Supply Co.; **Charles T. Reichert,** National Supply Co.; and the late Ray Zell, Union Oil Co., received citations for service at the American Petroleum Institute's Division of Production Pacific Coast district meeting last week. **D. L. Connelly,** Warren Petroleum Corp., and A.P.I. vice president for production, presented the awards, which recognize outstanding service to the A.P.I. and to the industry.

A.P.I. Rocky Mountain Production Officers Elected

New officers serving the Rocky Mountain district of the A.P.I. Production Division in 1957-58 are, left to right, J. J. Oldham, R. L. Manning Co., Casper, vice chairman for Wyoming; Claude E. Peavy, Britalta Petroleums, Ltd., Calgary, vice chairman for Canada; Wayne E. Glenn, Continental Oil Co., Denver, retiring district chairman, who has been elected chairman of the district advisory committee; L. A. Lindstrom, Ohio Oil Co., Sidney, vice chairman for Nebraska; George Goodin, Petroleum Information, Casper, chairman of the district; and Warren L. Taylor, El Paso Natural Gas Co., Salt Lake City, reelected vice chairman of Utah. Not pictured were Hugh Palmer, Cardinal Drilling Co., Bismarck, vice chairman for North Dakota; O. L. Odale, Shell Oil Co., Denver, vice chairman for Colorado; Auby Rowe, Jr., McAlester Fuel Co., Billings, vice chairman for Montana; and Ernie Howell, Northern Mud Co., Billings, district secretary-treasurer.

J. B. Ladd, formerly district petroleum engineer with The Texas Co. in Craig, Colo., has joined Consolidated Rimrock Oil Corp. as vice president and manager of operations with headquarters in Denver.

Lysle R. Kirk has been promoted to chief geologist for Ohio Fuel Gas Co., Columbus, Ohio. Kirk succeeds **K. C. Cottingham,** who has retired. Kirk was recently elected chairman of the American Petroleum Institute's Division of Production, eastern district. He has been with Ohio Fuel Gas Co. since 1936.

V. K. Leonard has been named manager of Shell Oil Co.'s pipeline department with headquarters in New York. He was formerly general superintendent of products pipelines in Indianapolis. Leonard succeeds **H. E. Dischinger,** manager of pipelines since 1954, who will retire June 30. Dischinger has been with Shell since 1926. Leonard joined the company in 1939 and has been general superintendent of products pipelines since 1954. **J. F. Johnson, Jr.,** northern division pipeline superintendent, has been named to succeed Leonard. Johnson joined Shell in 1936.

Charles A. Floto, vice president and general manager of Benedum-Trees Oil Co., has been elected a director of Plymouth Oil Co. He succeeds the late A. B. Dally, Jr., on the Plymouth board.

Personals

George W. Garman has joined Sohio Petroleum Co.'s exploration department at Midland, Tex.

Willard Blevins, Sullivan, Ind., geologist, has joined Hoagland Drilling Co. in Robinson, Ill.

S. A. Womack has been named head of the new Lafayette, La., office of American Louisiana Pipeline Co. **Frank W. Harrison** has been appointed district geologist there.

Jack H. Heathman and **H. D. Shreve** have formed Heathman Oil Co. in Wichita. They were formerly associated with **A. A. Seeligson, Jr.,** in Heathman-Seeligson Drilling Co.

Fred A. Jennings, plant foreman with Natural Gas Pipeline Co. of America, has been named storage foreman for Natural Gas Storage Co. of Illinois and has transferred to Mattoon, Ill., from Gray, Okla.

Fred S. Schwend, vice president and general manager of Warren Petroleum Corp.'s L.P.G. division, has been appointed vice president in charge of four of the company's service departments and three of its affiliated companies, including two distribution companies and Okan Pipeline Co. Schwend has been a vice president of Warren since 1956 and has been manager of the L.P.G. division since 1954.

DEATHS

Dr. Byron Blackburn Boatright, 57, vice president and general manager of Houston Natural Gas Production Co., died recently at his home in Houston. Boatright had a varied oil industry career which included work as an engineer with the U. S. Bureau of Mines and the old Marland Oil Co. For several years he was head of the petroleum engineering department at Colorado School of Mines. He was later vice president and chief engineer of Republic Natural Gas Co. and then vice president and director of Conroe Drilling Co. before joining Houston Natural Gas in 1953.

James W. Keys, 84, retired independent oil operator, died recently at his home in Albany, Tex.

Henry B. Welp, 72, retired drilling contractor and Tulsa independent, died May 14 in Guthrie, Okla.

Merton Morris Waite, 80, Dewey, Okla., drilling contractor and independent producer, died May 14 in Bartlesville, Okla. A pioneer oil man, Waite was active in early Kansas oil discoveries and settled in Oklahoma just before statehood.

Joseph B. Wood, 78, chairman of the board of Technical Oil Tool Corp., Los Angeles, died recently. Wood was a pioneer in the development of Technical Oil Tool's drift indicator. He had been president of the company until 1953 and chairman since that time.

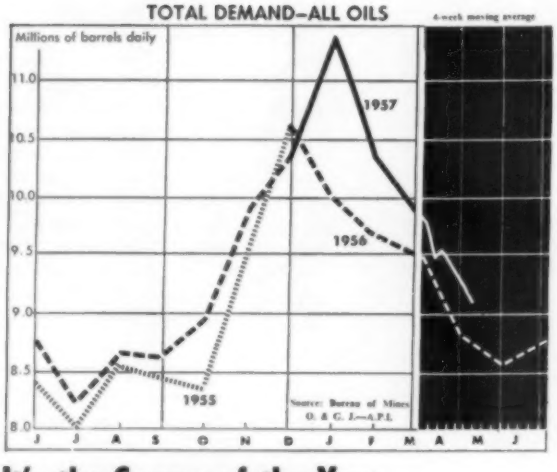
Fred A. Eshbaugh, 72, retired traffic manager of Phillips Petroleum Co.'s Okmulgee, Okla., refinery, died May 12 in Tulsa.

William Hatton Clark, 87, retired drilling superintendent for Colorado Oil Co. in Olinda, Calif., died recently in Los Angeles. He retired in 1927.

Latest Figures . . . Industry Trends

A QUICK LOOK AT THE HIGHLIGHTS

	LATEST WEEK	Change from WEEK AGO		Change from YEAR AGO	
Production	7,422,425	DOWN	100,150	UP	382,839
Crude stocks	262,870,000	UP	3,185,000	DOWN	12,550,000
Completions	1,053	UP	137	DOWN	69
Refinery runs	8,050,000	UP	417,000	UP	139,000
Gasoline stocks	197,402,000	DOWN	930,000	UP	9,694,000
Kerosine stocks	21,907,000	UP	742,000	UP	2,575,000
Distillate stocks	82,260,000	UP	3,141,000	UP	17,315,000
Residual stocks	38,745,000	UP	1,174,000	UP	5,626,000
Four-product stocks	340,314,000	UP	4,127,000	UP	35,210,000
Total imports	1,285,600	DOWN	235,100	DOWN	143,300



It's the Season of the Year For Changes in Product Prices

PRODUCT markets are shifting under the influence of seasonal changes in demand, improvement in product quality, transportation costs, and inventory positions.

Esso Standard Oil Co. announced its summer-fill program for light heating oils on May 9. The program calls for a discount of 0.5 cent a gallon for kerosine and No. 2 fuel for barge, tank-car, and wholesale deliveries. Esso also cut heavy fuel 10 cents a barrel on May 15.

Atlantic Refining Co. had reduced distillate prices in the Philadelphia area by 0.4 cent a gallon on May 7. A further discount of 0.1 cent a gallon brings the price in line with the half-cent reduction that is becoming general for the East Coast area north of Charleston.

The normal seasonal drop in demand for light fuels has been a factor in the lower prices quoted for kerosine and No. 2. Increased demand for distillates at Gulf Coast ports during the winter months was due in part to shipments to Europe during the Suez crisis. The decrease in liftings for Europe came at about the same time that spring weather cut sales of distillates for home heating in this country. This combination produced a steeper-than-normal drop in distillate demand. Sharp changes in demand, even if predictable, tend to produce changes in product prices.

Lower tanker rates have reduced the spread between costs in New York Harbor and at shipping points on the Gulf Coast. Spot tanker rates for shipments of clean products from the Gulf Coast to the East Coast climbed to 225 per cent above the USMC base rate by the middle of last December. This represented a transportation cost of $9.26 a long ton for light products or a little less than 3 cents a gallon for No. 2 fuel. Current spot rates for clean tankers average about 20 per cent under the USMC base rate or about 0.72 cent a gallon for No. 2 fuel.

Even though only a minor portion of the total Gulf-East Coast movement of product is in spot-rate tankers, changes in spot rates produce changes in the spread between Gulf Coast prices and postings on the East Coast.

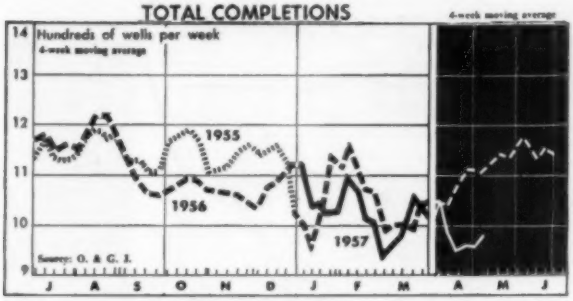
The inventory level for a particular product is a big factor in determining the spot price of that product. And, since Gulf Coast products can move either inland or to the Gulf Coast, heavy inventories in one area may put pressure on prices in many areas.

The stock total for the four major products is up 35,210,000 bbl. from this time last year with increases reported for all products. Almost half of the increase is in distillate stocks, but part of the gain is due to the fact that inventories were low last year, following a late cold spring. Gasoline is up 9,694,000 from last year, and the total for May 11 last year was up 16,674,000 bbl. over the year before. Some refiners have been pressed for storage space. The resulting distress sales have pushed gasoline prices down.

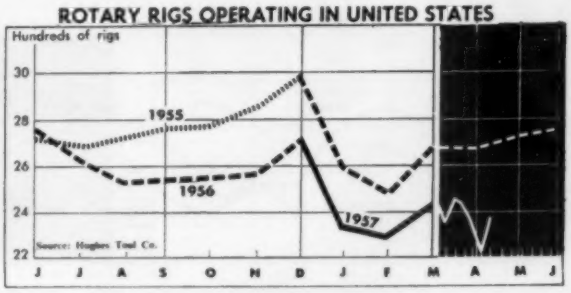
Mid-Continent refiners have raised the octane quality of gasolines moving through the Great Lakes Pipe Line. Premium is up two octane numbers and regular up one. Premium gasoline, testing 98 octane, started in the line on May 1.

Prices for premium and regular will be raised as soon as the new material is available at most of the pipeline terminals.

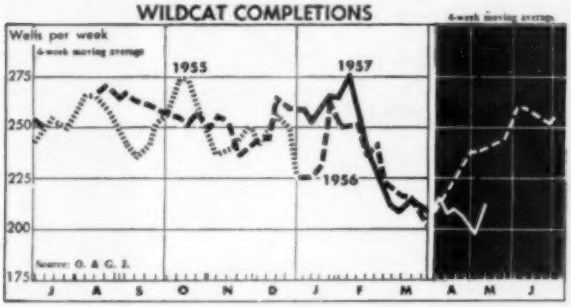
TOTAL COMPLETIONS



ROTARY RIGS OPERATING IN UNITED STATES



WILDCAT COMPLETIONS



ACTIVE ROTARY RIGS*

Area—	5-13-57	5-6-57	5-14-56
North Central and East	127	110	121
Southeast	41	42	34
Okla., Kans., Ark., Mo.	427	371	521
Louisiana	419	411	435
North and East Texas-Panhandle	327	258	455
Gulf and South Texas	206	201	264
West Texas-New Mexico	514	516	565
Rocky Mountain	228	228	242
Pacific Coast	94	96	127
Total United States	2,383	2,233	2,764
Canada	160	122	176

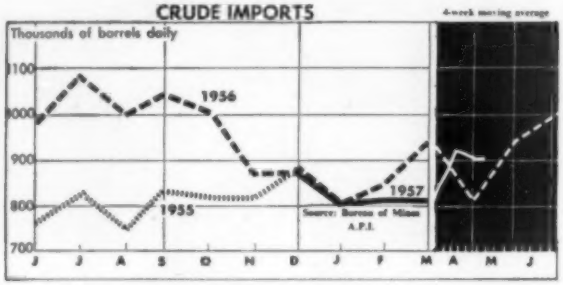
*Hughes Tool Co.

WEEKLY WELL COMPLETIONS . . . WEEK ENDED MAY 11, 1957

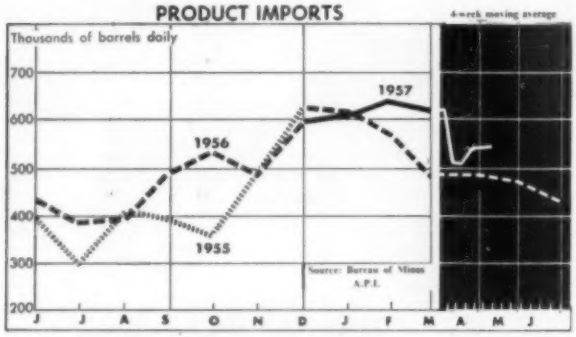
	Total of all wells					Cum.		Wildcat completions and discoveries					Cumulative total, 1957				
	Comp.	Oil	Gas	Dry	Footage	1957	1956	Oil	Dist.	Gas	Dry	Total	Oil	Dist.	Gas	Dry	Total
Ala.-Ga.-Fla.	†2	2	0	0	23,649	43	37	0	0	0	0	0	0	0	1	16	17
Arkansas	12	11	0	1	37,853	352	285	0	0	0	1	1	7	0	2	46	55
California**	85	63	1	21	342,598	757	765	3	0	0	16	19	22	0	2	164	188
Colorado	15	1	2	12	71,251	334	415	0	0	2	10	12	13	0	6	204	223
Illinois	40	11	2	27	86,988	833	1,250	2	0	0	12	14	11	0	1	193	205
Indiana	8	1	1	6	11,183	217	217	0	0	0	1	1	4	0	0	40	44
Kansas	66	28	6	‡32	233,763	1,493	1,830	0	0	0	8	8	43	0	10	223	276
Kentucky	15	5	1	9	30,279	489	604	0	0	0	1	1	12	0	4	87	103
Louisiana	95	50	10	35	781,858	1,359	1,370	1	0	3	13	17	30	9	34	169	242
North	27	17	0	10	74,707	467	523	0	0	0	0	0	4	0	2	44	50
South	49	22	9	18	528,877	639	675	1	0	3	10	14	19	8	26	106	159
Offshore	19	11	1	7	178,274	253	172	0	0	0	3	3	7	1	6	19	33
Michigan	8	2	0	6	19,187	142	166	0	0	0	2	2	4	0	0	55	59
Mississippi	9	3	0	6	55,737	131	165	0	0	0	4	4	7	0	0	52	59
Montana	3	1	0	2	24,754	115	116	0	0	0	2	2	3	0	0	38	41
Nebraska	20	6	0	14	121,340	282	341	1	0	0	12	13	16	0	0	139	155
New Mexico	38	18	9	11	169,913	713	647	1	0	1	1	3	27	1	6	70	104
Northwest	11	2	8	1	57,124	257	221	0	0	1	0	1	12	1	5	23	41
Southeast	27	16	1	10	112,789	456	426	1	0	0	1	2	15	0	1	47	63
New York	10	4	1	‖5	12,733	168		0	0	1	0	1	0	0	1	0	1
North Dakota	4	1	0	3	29,439	102	85	0	0	0	3	3	5	0	0	35	40
Ohio	26	17	0	§9	48,580	369	384	0	0	0	0	0	0	0	0	3	3
Oklahoma	117	73	5	¶39	429,292	2,389	3,181	0	0	0	12	12	36	8	6	224	274
Pennsylvania	1	0	1	0	7,692	324	*401	0	0	1	0	1	0	0	14	18	32
Texas	444	257	15	172	1,808,565	7,901	7,824	14	1	3	102	120	240	23	75	1,725	2,063
Southwest (1 & 4)	53	23	0	30	242,221	963	1,149	0	1	0	22	23	32	9	21	294	356
Gulf Coast (2 & 4)	44	23	1	20	276,576	906	990	1	0	0	15	16	18	10	37	254	319
East (5 & 6)	24	13	2	9	120,491	455	416	0	0	0	6	6	4	0	2	134	140
N. Central (7-B & 9)	169	83	3	83	491,227	2,838	2,763	10	0	3	42	55	131	0	8	729	868
West (7-C & 8)	124	93	3	28	574,716	2,245	2,084	2	0	0	17	19	51	0	6	290	347
Panhandle (10)	30	22	6	2	103,334	494	422	1	0	0	0	1	4	4	1	24	33
Utah	6	2	1	3	32,763	66	32	0	0	1	3	4	5	0	3	32	40
West Virginia	8	2	5	1	19,873	219	236	0	0	0	0	0	0	0	7	3	10
Wyoming	21	11	3	‡7	93,213	284	267	1	0	1	3	5	11	0	3	83	97
Miscellaneous	0	0	0	0	0	26	54	0	0	0	0	0	0	0	1	20	21
Total U. S.	1,053	569	63	421	4,492,503	19,108	20,672	23	1	13	206	243	496	41	176	3,639	4,352
Total previous week	916	501	46	369	3,796,705			26	3	6	164	199	473	40	163	3,433	4,109
Total May 12, 1956	1,122	610	64	448	4,635,460			26	2	15	215	258	556	61	136	3,743	4,496
Cumulative 1957	19,108	10,244	1,369	7,495	79,239,888												
Western Canada	43	27	7	9	252,150	894	823	2	0	2	7	11	23	0	19	200	242

Service wells included: ‡2, §1, ¶4, ‖5. *Incl. N. Y. †Ala. **Incl. week of March 30.

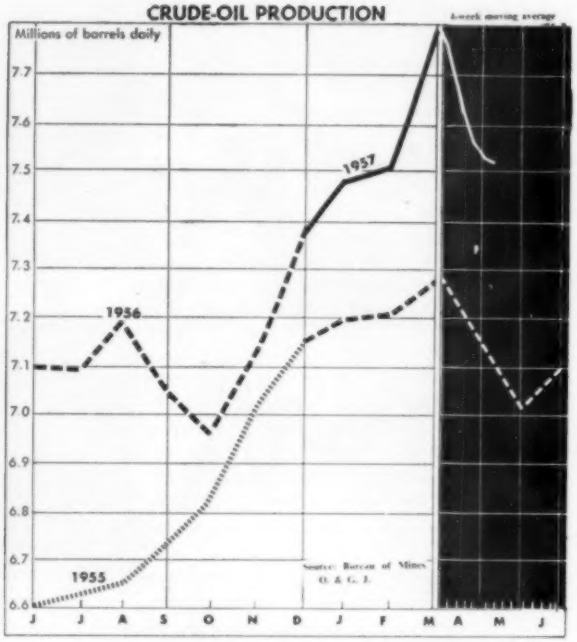
CRUDE IMPORTS



PRODUCT IMPORTS



CRUDE-OIL PRODUCTION

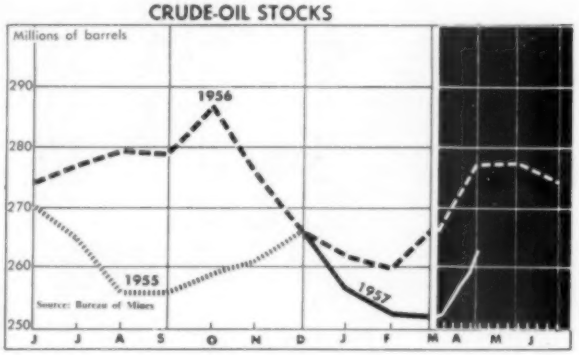


DAILY AVERAGE PRODUCTION FOR WEEK

	May 11, 1957 Crude oil	Lease condensate	Total	May 4 total
Alabama	11,850	.....	11,850	11,900
Arkansas	85,175	325	85,500	85,500
California	928,000	.....	928,000	928,400
Colorado	158,200	.....	158,200	157,750
Eastern	50,600	.....	50,600	51,000
Florida	1,250	.....	1,250	1,225
Illinois	231,600	.....	231,600	229,800
Indiana	32,800	.....	32,800	33,400
Kansas	†337,800	.....	†337,800	†372,750
Kentucky	47,300	.....	47,300	47,500
Louisiana	853,000	73,200	926,200	941,150
North	130,500	3,200	133,700	133,500
South	722,500	70,000	792,500	807,650
Michigan	26,400	.....	26,400	26,700
Mississippi	110,650	4,375	115,025	114,675
Montana	72,200	.....	72,200	72,250
Nebraska	50,800	.....	50,800	49,300
Nevada	100	.....	100	100
New Mexico	264,650	4,600	269,250	271,850
North Dakota	31,700	.....	31,700	26,600
Oklahoma	†590,000	.....	†590,000	†627,200
Texas	3,107,000	53,800	3,160,800	3,185,375
Dist. 1	57,000	450	57,450	56,875
Dist. 2	148,000	8,350	156,350	160,350
Dist. 3	440,000	26,300	466,300	468,600
Dist. 4	231,000	6,300	237,300	245,300
Dist. 5	40,000	400	40,400	41,550
Dist. 6	136,000	6,000	142,000	144,275
East Texas field	205,000	.....	205,000	208,150
Dist. 7-B	167,000	75	167,075	167,650
Dist. 7-C	170,000	3,800	173,800	174,375
Dist. 8	1,185,000	1,100	1,186,100	1,191,800
Dist. 9	218,000	700	218,700	216,425
Dist. 10	110,000	325	110,325	110,025
Utah	9,200	.....	9,200	11,100
Wyoming	285,750	.....	285,750	276,950
Others	‡100	.....	‡100	‡100
Total U. S.	7,286,125	136,300	**7,422,425**	7,522,575
Change from prev. week, down			**100,150**	
Canada	†469,500	.....	†469,500	†494,800
Total U. S. prod., Jan. 1-May 11				996,801,125 bbl.
Same period last year (crude plus cond.)				*949,940,232 bbl.

*Includes 17,071,800 bbl. condensate. †Week ended previous Monday. ‡South Dakota.

CRUDE-OIL STOCKS



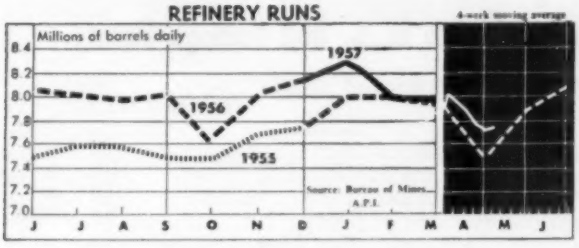
CRUDE-OIL STOCKS BY STATES OF ORIGIN*

(Thousands of barrels)

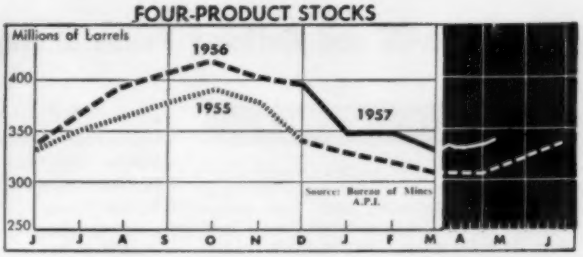
	5-4-57	4-27-57	5-5-56
Pennsylvania Grade	2,778	2,733	2,737
Other Appalachian	1,925	1,822	2,230
Illinois, Indiana, Michigan	9,585	9,055	9,637
Nebraska, North Dakota	1,427	1,855	2,313
Kansas	10,195	9,719	9,024
Oklahoma	22,192	22,401	25,349
Arkansas	2,860	2,842	3,181
Louisiana	18,621	18,321	17,457
North	2,982	2,815	2,627
South	15,639	15,506	14,830
Mississippi	2,431	2,304	3,124
New Mexico	7,282	6,936	7,828
Texas	120,516	118,565	127,269
East Texas proper	11,116	11,111	9,425
West Texas	56,647	55,811	62,809
Texas Gulf	22,422	21,550	22,630
Other Texas	30,331	30,093	32,405
Wyoming	16,428	17,032	17,587
Other Rocky Mountain	6,077	6,041	5,988
California	26,795	26,806	28,542
Foreign	†13,758	13,253	13,154
Total	262,870	259,685	275,420

*Bureau of Mines. †Includes 2,945,000 bbl. in California.

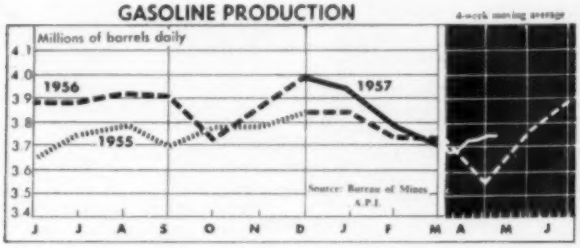
REFINERY RUNS



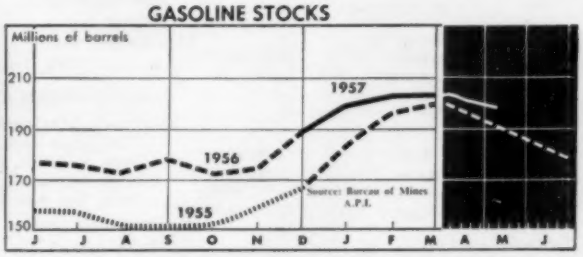
FOUR-PRODUCT STOCKS



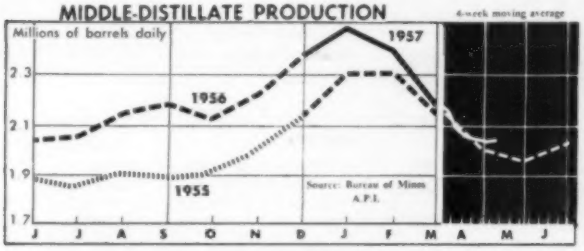
GASOLINE PRODUCTION



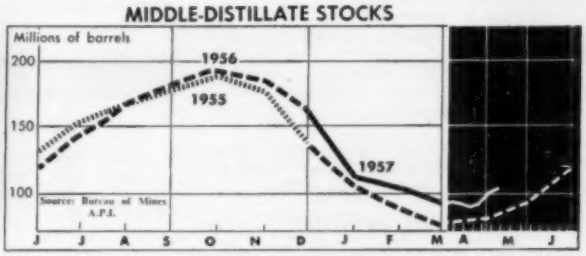
GASOLINE STOCKS



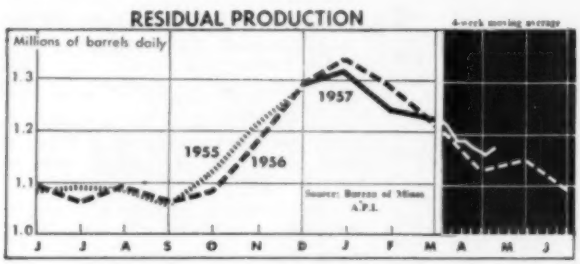
MIDDLE-DISTILLATE PRODUCTION



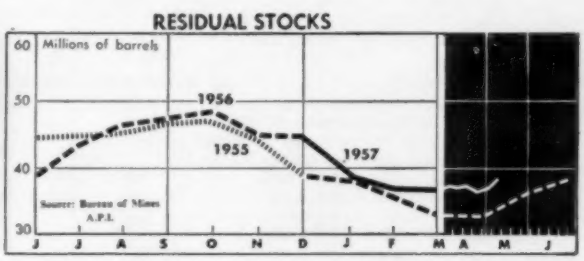
MIDDLE-DISTILLATE STOCKS



RESIDUAL PRODUCTION



RESIDUAL STOCKS



A.P.I. REFINERY REPORT, MAY 10, 1957

(Thousands of barrels)

District—	avg. runs Daily	Gaso.* Daily average	Kero.	Dist. production	Resid.	Stocks‡ Gaso.†	Kero.	Dist.	Resid.	Bureau of Mines, May 1956 Daily avg. runs	Daily average production Gaso.*	Kero.	Dist.	Resid.
East Coast	1,219	478.3	37.9	318.4	212.4	43,451	9,202	26,118	9,672	1,043	417.0	27.6	239.6	196.5
Appalachian:														
District 1	98	35.1	4.4	17.3	3.4	5,074	486	1,845	480	93	35.5	3.7	22.4	4.0
District 2	105	55.4	4.7	18.1	13.3	2,763	377	602	362	106	49.7	4.0	17.2	15.0
Ind., Ill., Ky.	1,423	703.0	62.9	290.9	175.9	36,277	3,678	12,820	5,041	1,359	678.3	70.7	253.8	167.4
Minn., Wis., Dak.	100	50.0	4.7	29.3	9.3	6,107	741	3,537	386	79	36.7	5.0	22.4	5.8
Okla., Kans., Mo.	674	376.9	20.9	147.9	44.9	18,785	1,004	7,729	906	704	377.9	18.9	151.1	30.1
Inland Texas	280	191.4	7.1	55.6	21.4	7,978	268	1,725	1,740	280	199.0	8.4	52.6	24.0
Texas Gulf Coast	1,876	840.2	89.4	492.8	219.1	26,425	2,601	9,181	4,653	2,019	939.9	98.1	480.4	262.3
La. Gulf Coast	654	331.0	48.0	194.0	43.7	10,709	2,279	4,692	1,309	710	362.9	38.5	169.9	52.0
N. La. and Ark.	84	24.1	6.4	16.6	3.7	4,320	705	1,559	79	97	30.1	5.3	24.2	6.1
Rocky Mountain:														
New Mexico	28	13.3	0.6	5.1	3.4	395	28	104	60	22	11.6	0.4	4.1	3.2
Other Rocky Mtn.	268	126.4	2.0	59.6	37.3	7,667	231	2,463	1,107	270	121.5	3.8	63.4	32.7
California	1,241	491.9	8.1	179.0	407.9	27,451	307	9,885	12,950	1,114	496.0	7.8	165.5	349.6
May 10, 1957	8,050	3,717.0	297.1	1,824.6	1,195.7	197,402	21,907	82,260	38,745	7,896	3,756.1	292.2	1,666.6	1,148.7
May 3, 1957	7,633	3,744.9	292.6	1,752.0	1,136.0	198,332	21,165	79,119	37,571	.....	.....	.....	.....	.....
May 11, 1956	7,911	3,771.9	323.3	1,637.4	1,177.7	187,708	19,332	64,945	33,119	.....	.....	.....	.....	.....

*At refineries including natural blended. †Finished and unfinished. ‡At refineries, bulk terminals, in transit, and in pipelines.

Crude-Oil and Refinery Prices at Representative U. S. and Foreign Points

REFINED-PRODUCT PRICES

Following quotations are for refinery products in cents per gallon moving in interstate shipments on Wednesday each week unless otherwise noted. Crude-oil prices are per barrel at the wells unless otherwise listed.

GASOLINE*

Mid-Continent (Group 3):	
Regular (88 octane)	11.75-12.25
Premium (96 octane)	13.50-14.00
Gulf Coast (cargoes for coastwise or export movements):	
Regular (90 octane)	10.75-11.25
Regular (92 octane)	11.00-11.50
Premium (97 octane)	12.75-13.25
Premium (98 octane)	13.00-13.50
California (rack):	
Regular (86 octane)	13.1
Premium (93 octane)	15.3
Premium (96 octane)	16.2
Caribbean area (cargoes):	
Regular (87 octane)	10.875
Premium (93 octane)	11.75

*Quotations are for octanes shown. Prices usually vary with octane ratings within the regular, premium, and aviation grades.

NATURAL GASOLINE*

Group 3:	
Grade 26-70	4.0
Breckenridge:	
Grade 26-70	3.5

*If 26-70 natural is considered as 100 per cent, prices for lower-vapor-pressure grades increase 2.5 per cent for each unit drop in Reid vapor pressure down to and including 16-lb. Prices for grades below 16-lb. may vary slightly by areas or plants.

KEROSINE AND DISTILLATE

Mid-Continent (Group 3):	
Kerosine 42-44	10.00-10.375
Diesel oil (58 d.i. and above)	9.625-9.875
Distillate No. 1	9.625-9.875
Distillate No. 2	9.00-9.375
Gulf Coast (cargoes):	
Kerosine 41-43	10.25-10.75
Distillate No. 2	9.75-10.25
New York Harbor (barges):	
★ Kerosine 41-43	11.75
★ Distillate No. 2	11.15
★ Diesel fuel, 48-52 d.i.	11.45
Caribbean area (cargoes):	
★ Distillate No. 2	9.75-10.00

WAX (LB.)

Oklahoma (Group 3):	
132-135 A.m.p. (semi-refined) in tank cars	6.50
New York (export):	
126-130 A.m.p. crude scale (solid in bags or barrels	7.35

★Denotes change from previous week.

RESIDUAL FUEL (BBL.)

Mid-Continent (Group 3):	
Residual fuel (max 1% S)	$2.25-2.35
Gulf Coast (cargoes):	
Bunker C fuel	$2.75-3.00
New York Harbor (barges):	
★ Bunker C fuel	$3.10-3.20
Caribbean (cargoes):	
Bunker C	$2.55
California (rack):	
Bunker C fuel, Los Angeles	$2.85-3.00

LUBRICATING OILS

Mid-Continent (Group 3):	
150-160 bright stock, solvent refined, 0-10 p.p., 95 v.i.	25.5
200 vis. neutral oil, solvent refined, 0-10 p.p., 95 v.i.	22.25
Pennsylvania Grade:	
145-155 vis. at 210, bright stock, 8 color, 25 p.t.	28
200 vis. neutral (180 at 100°), 25 p.t.	26

CRUDE-OIL PRICES

GRAVITY SCHEDULE

	Signal Hill, Calif.	Mid-Cont.*	Gulf Coast Tex.†	West Tex.‡ N.M.	Wyo. (sour)
14-14.9	$2.67	....	....	....	....
15-15.9	2.71	....	....	....	$1.89
16-16.9	2.74	....	....	....	1.94
17-17.9	2.78	....	....	....	1.99
18-18.9	2.82	....	....	....	2.04
19-19.9	2.85	....	....	....	2.09
20-20.9	2.89	$2.75	....	$2.62	2.14
21-21.9	2.93	2.77	....	2.64	2.19
22-22.9	2.97	2.79	....	2.66	2.24
23-23.9	3.01	2.81	$3.44	2.68	2.29
24-24.9	3.05	2.83	3.46	2.70	2.34
25-25.9	3.09	2.85	3.48	2.72	2.39
26-26.9	3.13	2.87	3.50	2.74	2.44
27-27.9	3.17	2.89	3.52	2.76	2.49
28-28.9	3.22	2.91	3.54	2.78	2.54
29-29.9	3.27	2.93	3.56	2.80	2.59
30-30.9	3.32	2.95	....	2.82	2.63
31-31.9	3.38	2.97	....	2.84	2.67
32-32.9	3.44	2.99	....	2.86	2.71
33-33.9	3.50	3.01	....	2.88	2.75
34-34.9	3.56	3.03	....	2.90	2.79
35-35.9	3.61	3.05	....	2.92	2.83
36-36.9	3.65	3.07	....	2.94	2.87
37-37.9	3.68	3.09	....	2.96	2.89
38-38.9	....	3.11	....	2.98	2.91
39-39.9	....	3.13	....	3.00	2.93
40 and up	....	3.15	....	3.02	2.95

*Includes Oklahoma, part of Kansas, North Dakota, West Texas (sweet) and North Central Texas. †Low Cold test Gulf Coast. ‡Sour.

Effective dates: California January 17, 1957, east of California, January 3-January 10, 1957; Pennsylvania Grade, January 16, 1957.

Some crudes in North Central Texas and West Central Texas, are on the intermediate schedules.

FLAT PRICES

Louisiana:	
Bienville (distillate)	$3.05
Ville Platte	3.45
Texas:	
East Texas	3.25
Conroe	3.53
Van	3.08
Pennsylvania Grade:	
Bradford	4.88
Middle District	4.70
Southwest Pennsylvania	4.41
West Virginia	4.23
Buckeye Grade	4.23
Zanesville Grade	3.27
Illinois Basin	3.15
Canada:	
Leduc-Woodbend	2.78
Redwater (Alta.)	2.67
Smiley (Sask.)	2.44
Pembina	2.65

FOREIGN

Venezuela:	
Cumarebo, 48°-49.9°, Tucupido	3.75
San Joaquin, 40°-40.9°, Puerto La Cruz	3.37
Oficina, 35°-35.9°, Puerto La Cruz	3.05
Tia Juana medium, 26.5°-26.9°, Amuay*	2.55
Quiriquire, 16.5°-16.9°, Caripito	2.45
Lagunillas heavy, flat, Amuay or Las Piedras*	2.38
Bachaquero, flat, Las Piedras*	2.23

Prices for all crudes of 24° or lighter vary 2 cents per degree change, up or down. All crudes heavier than 24° vary 2.5 cents per half-degree gravity change.

*Also available at La Salina at 3 cents per barrel less.

Middle East, Persian Gulf (cargoes, f.o.b. lifting port):	
Arabian, 36.0°-36.9°, Ras Tanura	$1.97
Iranian, 34.0°-34.9°, Bandar Mashur	1.91
Iranian, 34.0°-34.9°, Abadan	1.86
Iraq, 36.0°-36.9°, Fao	1.87
Kuwait, 31.0°-31.9°, Mina-al-Ahmadi	1.72
Qatar, 39.0°-39.9°, Umm Said	2.06
Middle East, E. Mediterranean:	
Arabian, 36.0°-36.9°, Sidon	2.69
Iraq, 36.0°-36.9°, Tripoli, Banias	2.69
Far East (cargoes, f.o.b. Lutong, Sarawak):	
Seria Light, 37°-38°	2.60

TANKER RATES PER LONG TON

(Latest reported spot fixtures)

★ Gulf-U.S.N.H., clean (USMC—15%)	$2.42
Gulf-U.S.N.H., dirty (USMC—27.5%)	2.07
★ N.W.I.-U.S.N.H., dirty (USMC—35%)	1.76
★ N.W.I.-Los Angeles, dirty (USMC—35%)	3.87
★ P.G.-U.S.N.H., dirty (USMC—20%)	10.16
★ P.G.-San Francisco (USMC—30%)	11.41

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VERTICAL MAGNETOMETER Temperature Compensated Ten Gammas Askania 1955, $1100.00. Calibrating coil, $125.00. Box K-155, The Oil and Gas Journal, Tulsa, Oklahoma.

FOR SALE at our Okla. City warehouse—1 45 HP Happy No. One pumping unit, $2500.00. Also 1 Lufkin No. 58, size 6½. Ditto less beam, Sampson Post and Pitman $1000.00. See T. P. Mace at Whse. Cities Service Oil Company, Patridge, Bartlesville.

1 36L BUCYRUS Spudder complete with 5 and 7 inch tailing in tools. Dog house, butane tank, junk rack and light plant. Rod and tubing tools and hand tools. Phone Office 144, Res. 614, Cleveland, Oklahoma.

LIQUIDATION—Drumright, Okla.

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Modern 15,000 Bbl./Day Refinery

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8'x5'x85'6" 25 Trays 250 PSI
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4'6"x30'5"x⅜" 14 Trays
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3'x23'6"x1¼" Catalyst 600 PSI (2)

ETHYL BLENDING PLANT 8500 GAL. COMPLETE SKIMMING POND

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6'x40' SOAKER, 500 PSI @ 850° F.
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Sq. Ft.	Type	Tubes	Shell
1080	Reflux	Adm. 125#	Steel 250
993	Reboiler	Steel 600#	" 600
970	"	" 125#	" 250
750	"	" —	—
331	16-138	Adm. 250#	Steel 250
331	16-138	Adm. 125#	" 250
Brown	Fintube	Steel 600#	(11)

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500—New Crolay #5, 3" to 6⅝" OD 15' to 32' long
500—4", 4-6% Chrome, headers
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HOT OIL 334 GPM, 1,000 PSI (2)
FIRE 2500 GPM at 426' head
CENTRIFUGAL from 60 to 1500 gal. from 40' to 655' head
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HEAT EXCHANGERS—196-3100 sq. ft. (25)
NEW STEEL STACKS—240'
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MACHINE TOOLS—WELDERS—
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Your inspection invited—representatives on premises
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A clean D7 Caterpillar tractor, series 4T with an inside hydraulic 8' blade and a D7N Hyster worm driven winch. Serial #19131.

For further information concerning this equipment call

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FOR SALE EQUIPMENT

FOR SALE EQUIPMENT

LIQUIDATION 11,000 BBL. REFINERY

D-X SUNRAY OIL CO., ALLEN, OKLA.

We are now liquidating this modern refinery and can offer equipment at a fraction of its cost.

INCLUDED ARE: 6 Heaters with Chrome Tubes, Welded Towers from 2' to 8' with Operating Pressures up to 475 psi., Reboilers, Accumulators, Heat Exchangers, Hot Oil Pumps, Centrifugal and Steam Pumps, Boilers, Gas and Diesel Generator Sets, New Chrome Heater Tubes, Pipe, Valves, etc.

Your Inspection Is Invited. Write for Catalogue.

HEAT & POWER CO. Inc., 60 E. 42 St., New York 17, N. Y.
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FOR SALE: One 6XVG Ingersoll-Rand gas compressor, complete with accessories. Alfred B. Kern, 305 Kennedy Bldg., Tulsa, Oklahoma.

600 HP. RATHBUN-JONES Diesel Engine, with G.E. 250 KVA—200 KW—240 volt generator direct connected to line shaft; complete pneumatic starting equipment; fin-fan heat exchanger (16' x 11'—Fluor Corp. Los Angeles). Cooled by 10 ft. four bladed fan powered by 25 hp. motor. Closed cooling system eliminates scale problem. Six-cylinder, 16-in. bore, 24-in. stroke engine designed to operate 215-265 r.p.m. easily converted to natural gas operation. All new cylinder liners, pistons, bearings, and bushings. $12,500 f.o.b. The New Era Milling Company, Arkansas City, Kansas.

APPROXIMATELY 400,000'—8⅝"; 85,000'—12¾" used pipe, excellent condition, cleaned, beveled. Pipe & Equipment Exchange, 127 E. New York, Indianapolis, MElrose 5-8177.

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HELP WANTED

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Independent Oil Company has opening for experienced landman to direct and supervise land and geological activities. Must be familiar with Mid-Continent areas. Must be capable of handling all phases of land-geological operations, originating and closing deals. Age limit 40. Excellent salaried position. Do not answer unless fully qualified. In replying, give past employment record, educational background, and complete personal data. Reply

BOX K-184,
THE OIL AND GAS JOURNAL,
TULSA, OKLAHOMA.

Public Relations

Man under 35 for independent producing and drilling company. Will handle customer and public relations program. Must have excellent personality, character, and reputation. College graduate preferred, with some experience in oil business or allied service companies. Reply giving complete information as to past employment, education, references, and other qualifications.

Box K-183,
The Oil and Gas Journal,
Tulsa, Oklahoma.

HELP WANTED

WANTED: Graduate petroleum engineers with 4 to 6 years production and drilling experience for employment in the Louisiana Gulf Coast area with large independent, integrated oil company. Mr. E. E. Sands, 800 Prudential Building, Houston 25, Texas.

CHEMICAL ENGINEER

Chemical Engineer with distillation experience for research and development at midwestern laboratories of nationally known food company. Prefer applicant having up to 8 years experience, including a good background in pilot plant development in the field of distillation. Work involves initial investigation of a distillation problem and carries through to the ultimate design and start-up of a new process or equipment. Submit complete resume including education, work experience, and salary desired.

Box K-180,
The Oil and Gas Journal,
Tulsa, Oklahoma.

ANALYTICAL CHEMISTS

Immediate openings for chemists with BS or MS degrees in chemistry for analytical work with nationally known petroleum research organization.

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New modern air-conditioned laboratory located in suburban living area. Outstanding company benefits including vacation, liberal incentive plan, pension plan, life and health insurance.

Apply in person or write personnel director giving full resume of education, experience, and date available. All inquiries will be considered promptly and held strictly confidential.

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Southwest Research Institute
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Attention: S. J. Keane, Manager of Technical Services.

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Associate and Assistant Professors of Petroleum Engineering

If you have a Ph.D., some experience, and want to teach a select group of students in a leading western institution with facilities for research, and are young, able, and personable, communicate with the Dean of the School of Mineral Sciences, Stanford University, Stanford, California.

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Position open for graduate automotive or chemical engineer with knowledge of gasoline behavior research. The work is varied in nature and requires capable man to coordinate research, author technical publications and maintain contacts within the industry. Position offers immediate responsibility in a growing technical service activity. Location in a Detroit suburb offers ideal professional environment with a choice of city or suburban living. For more particulars send name and address to:

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Project manager required for European office of international consulting firm supervising technical aspects of construction and early operations of entirely new refinery. At least one year's service with good possibility of remaining in refinery operations. Require mature graduate engineer with refinery experience and good general knowledge of oil business. Excellent location in one of Europe's most attractive cities. Family transportation and living allowance included above excellent salary. Send resume to:

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The Oil and Gas Journal,
Tulsa, Oklahoma.

HELP WANTED

DEVELOPMENT GEOLOGIST to develop reservoir geology of producing fields and recommend drilling programs; experienced in logging and testing techniques. Initial work in South Texas with eventual coverage of North America. Box K-151, The Oil and Gas Journal, Tulsa, Oklahoma.

Experienced Asphalt Sales Engineer

Must be thoroughly familiar with pricing and specifications and have wide acquaintance. To be located in Mid-Continent area. Good opportunity for right man. State age, experience and starting salary expected. All replies will be kept strictly confidential.

Box K-129,
The Oil and Gas Journal,
Tulsa, Oklahoma.

GAS ENGINEER

For Caracas, Venezuela

CHEMICAL ENGINEERING DEGREE.
MINIMUM 5 YEARS EXPERIENCE

including compressor plant operations, design and operating gasoline plants and gas pipeline work. Capable setting up department when required and working with government representatives.

GOOD SALARY, ALLOWANCES,
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Send complete details to:

C. L. LAUE

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HELP WANTED

FOREIGN EMPLOYMENT. List oil companies, drilling contractors, seismograph contractors, showing where apply foreign jobs. $5.00 cash. OIML Co., Box 2603, Tulsa, Okla.

ENGINEERS WANTED: By crude oil pipe line operating company for general engineering. Applicants not over 30 years of age and must have a recognized degree in engineering from an accredited engineering school. Experience not essential. Salary based on experience and qualifications. When making application, please furnish resume of experience record, personal data, and copy of college transcript. Reply to EMPLOYEE RELATIONS DEPARTMENT, Interstate Oil Pipe Line Company, P. O. Box 1107, Shreveport, Louisiana.

CHEMICAL ENGINEER. Independent Oil Company needs Chemical Engineer under 35 with general knowledge of, and experience in construction, operation, and maintenance of gasoline plants, gathering systems, compressor stations, gas pipe lines, and related facilities, for permanent position in Louisiana. Knowledge of process engineering also helpful. Furnish information as to education, family status, work history, and salary requirements to P. O. Box 2162, Dallas 21, Texas.

Petroleum Refinery Chemical Engineers

Positions involving technical service and consulting type work for petroleum refineries are available in refinery technology division. Chemical engineers working in refinery process engineering or operation and economic analysis are well qualified for these positions. Positions offer a wide variety of work assignments in an expanding technical activity that works with sales, research, refinery, and company management problems. Positions also afford opportunities for industry-wide contacts with refining and process companies and for using initiative and individual expression to increase responsibility. Location in a Detroit suburb offers ideal professional environment with a choice of city or suburban living. For more particulars send name and address to:

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ETHYL CORPORATION
1600 W. EIGHT MILE ROAD
FERNDALE 20, MICHIGAN

HELP WANTED

RESERVOIR ENGINEER—permanent position with independent oil company for evaluation work, appraising oil and gas properties in various parts of U.S.A. and Canada. Headquarters Denver. Age limitation 28-35. Splendid opportunity for one with sufficient experience in valuation work, field analysis, well completions, property maintenance. Complete resume, photograph, professional engineer's registration number, or be qualified for registration. College transcript, 5 character and 5 professional references and salary expectation must be furnished prior to interview. 321 U. S. Nat'l Bank Building, Mile High Center, Denver, Colorado.

WANTED: Cable Tool Driller, 10 years experience. Write William Geer, Western Foundation Corporation, Two Park Avenue, New York 16, N. Y.

INSPECTION METHODS ANALYST

Foreign Employment

Career opportunity for graduate mechanical or metallurgical engineer with minimum 10 years experience in design and/or inspection of petroleum producing and refining equipment. Must have actual 5 years inspection experience requiring thorough knowledge of methods procedures and inspection equipment. To develop methods of inspection and give consultation and guidance to engineers and inspection personnel in proper application and use of inspection procedures, tools and equipment. Assignment in Saudi Arabia.

High salary plus living allowance and liberal all inclusive benefits conducive to large savings. Excellent community facilities.

Write outlining background and experience. Please include telephone number.

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Large independent oil company has opening for graduate engineer with minimum ten years' experience in design and operation of gas processing plants. Man selected will be located in main office and will be in charge of process control of several plants located in Texas and Louisiana. Age to 40. Attractive salary, liberal retirement and benefit plans. Replies will be treated confidentially. Mail complete relevant information to

BOX K-175, THE OIL AND GAS JOURNAL,
TULSA, OKLAHOMA.

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— ENGINEERS —

PETROLEUM **RESERVOIR**
GAS **MECHANICAL**
DRILLING **PIPE LINE**

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- TEACHER-PRINCIPAL, Male. Must have B.S. in education.
- TEACHER-STAFF CAMP, Male or Female, Jr. H.S. English
- TEACHER-STAFF CAMP, Female. Age to 35. Single. 3 years experience, 1st, 2nd, 3rd grades.
- STENOGRAPHER, Male or Female. 1 year exp. Age to 32. Must be single.

All information confidential.

Send complete resume to:
OVERSEAS EMPLOYMENT SECTION

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Jobs in Iraq, new refinery, family accompanies. Excellent salaries and benefits, three year renewable contract. Age open. Must be U. S. citizen with refinery operating experience. Degree required.

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OUR FEE PAID

ASST. CHIEF COORDINATOR, lube and asphalt. Minimum 7 yrs. experience, including supervisory. Ch.E. Degree.

ENGINEERING OPENINGS for civil, electrical, project, mechanical, chemical engineers, minimum 3 yrs. experience.

All inquiries confidential. Send resumes of experience to:

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PERSONNEL SERVICE
616 S. Main • Tulsa, Okla. • GI 7-3193

SITUATIONS WANTED

GEOLOGIST: 35, desires Dallas location. 12 years major and independent oil company experience in surface and subsurface geology. Has organized and successfully operated exploration program for independent. Box K-185, The Oil and Gas Journal, Tulsa, Oklahoma.

GEOLOGIST: Five years varied experience in Mid-Continent Area with major and independent oil companies. Qualified to handle all phases of petroleum exploration and development. Currently employed. Box K-181, The Oil and Gas Journal, Tulsa, Oklahoma.

DRILLING SUPERINTENDENT with administrative experience. Employed 20 years in Mexico and South America. Capable of assuming entire responsibility of drilling operations. Desires foreign employment. Box K-106, The Oil and Gas Journal, Tulsa, Oklahoma.

GEOLOGIST: Four years exploration geology & reservoir studies. Desires position as production (exploration) geologist with a producing company. Currently employed with oil company. Single. Box K-176, The Oil and Gas Journal, Tulsa, Oklahoma.

GEOLOGIST—M.S. degree, young, 11 years experience as exploration geologist with major company primarily on Gulf Coast, Louisiana and Texas, have been in district geologist capacity for several years, extensive background in economics and evaluation of development and exploration including engineering aspects, for permanent location in Houston desire position with aggressive independent. Box K-179, The Oil and Gas Journal, Tulsa, Oklahoma.

PURCHASING - ADMINISTRATIVE: Ten years Oilfield Supply Company; Twelve years major oil company. Two jobs in twenty-two years. Age 41. Currently employed out of state; desire relocation in Houston. Excellent qualifications. Excellent references. Box K-182, The Oil and Gas Journal, Tulsa, Oklahoma.

WANTED

NEED GOOD PROVEN development or producing property up to several million dollars valuation. Reply with geological, engineering reports, records. W. D. Pye, Box 2586, Fargo, N. D.

WANTED—Semi-proven or proven leases or farmouts in South Texas or Gulf Coast. Please send complete details in first letter. P. O. Box 1937, San Antonio, Texas.

SITUATIONS WANTED

PETROLEUM EQUIPMENT ENGINEER: 8½ years experience with mechanical equipment in various phases of refinery and pipeline work. Looking for challenging position with chance for advancement into executive capacity. Prefer another overseas assignment. Opportunity more important than security. Box K-177, The Oil and Gas Journal, Tulsa, Oklahoma.

LATIN AMERICA—geological engineer, twenty years experience foreign operational problems in addition domestic available independent entering foreign field. Box K-173, The Oil and Gas Journal, Tulsa, Oklahoma.

PRODUCTION FOR SALE

I HAVE FOR SALE 500 bbls. oil per day loaded in your cars or mine in Wyoming. Operator, Box 2153, Denver, Colorado.

PRODUCTION WANTED

OIL PRODUCTION WANTED. Producing primary and potential secondary oil and gas production . . . any size, any amount. Send full particulars to: Box K-178, The Oil and Gas Journal, Tulsa, Oklahoma.

WANTED FOR CASH—Depleted and Marginal Wells for Salvage. Frank J. Black, P. O. Box 150, Phone 107, McPherson, Kansas.

WANT TO BUY—Oil Properties, settled or semi-settled production. 100 to 5,000 barrels daily in Oklahoma and Kansas. Contact Morris Sitrin, 1215 First National Building, Tulsa, Oklahoma.

PRODUCING oil, gas properties, also royalties wanted. Any size, any amount. Complete details in first letter. Box 231, Scarsdale, N. Y.

WANTED: Oil or gas production, any size, prefer, Okla., N. M., Tex., Colo. or Kan. B. Thurston, 1427 Princeton NE, Albuquerque, N. M.

WANTED—Oil or gas properties in South Texas or Gulf Coast. Please send complete details in first letter. P. O. Box 1937, San Antonio, Texas.

ELECTRIC LOG CABINETS

FOR ECONOMICAL FILING of full-size electric logs, most geologists prefer Kraftbilt E-24 4-drawer cabinet. Two compartments to each drawer with separate follow blocks make this cabinet handy, economical. For filing reduced electric logs, geologists use Kraftbilt E-28 8-drawer cabinet. Send for catalog 57-B. Ross-Martin Co., P. O. Box 800-A, Tulsa, Okla.

LEGAL

SEALED BIDS will be received until 2:00 P. M., Mountain Standard Time, June 4, 1957, and opened at that time in the Office of the Fort Peck Indian Agency, Poplar, Montana, for the leasing of 37,619.22 acres of tribal and allotted Indian lands, located in Roosevelt, Daniels, Sheridan Counties, Montana, and Williams County, North Dakota, for oil and gas mining purposes. The details of the lease offering and how and where to file bids may be obtained by addressing the inquiry to the Superintendent of the Fort Peck Indian Agency at Poplar, Montana, or telephone Poplar 2161.

WANTED

WANTED
MANUFACTURER'S AGENT
for California and Pacific Northwest States

To represent well known Valve Manufacturer located in Mid-Continent area with well established business and reputation in above area. Must be familiar with both Production, Refinery, and Petro-Chemical Plant sales. Wide acquaintance in these fields preferred. To headquarter in Los Angeles with warehouse facilities. Must be established in California with 3 or 4 non-conflicting lines. Commission basis. Good opportunity for right man. Write

Box K-163, The Oil and Gas Journal,
Tulsa, Oklahoma.

for further details and to arrange for interview.

EQUIPMENT MEN...

Parker, Norman Named to Hercules Sales Posts

The appointment of M. Leon Parker and R. A. (Bob) Norman as sales representatives for Hercules Tool Co. has been announced by S. P. Tschappat, president.

Parker is representative for the Wichita Falls and North Central Texas area. He will have headquarters in Wichita Falls.

Norman is representative for the Texas-Oklahoma Panhandle and western Oklahoma area. He has had experience with supply companies in the Borger area and in Colorado. He will make his headquarters at Borger, Tex.

All-Power Elects Evans as Vice Pres.-General Manager

General expansion of the facilities of All-Power Manufacturing Co. of Montebello, Calif., and election of L. G. Evans as vice president and general manager have been announced by M. E. Danielson, president.

Evans was formerly assistant to the president of Emsco Manufacturing Co., a division of Youngstown Sheet & Tube Co., with responsibility for manufacturing in the company's six plants in the United States, Mexico and England. Previously he was manager of Emsco's Garland, Tex., plant and chief engineer of the D+B division.

Hammond Names Eastern Sales Representatives

The appointment of E. F. Trombley as Hammond Iron Works' representative throughout Connecticut has been announced by Ralph E. Kramer, executive vice president. Gribbons Oil Equipment Co., South Weymouth, Mass., has been appointed Hammond Iron representative throughout Rhode Island and eastern Massachusetts.

Hammond Iron Works has plants at Warren and Bristol, Pa.; Birmingham, Ala.; Provo, Utah; and Casper, Wyo.

Combs Named Vice President, Gulf Division of Walworth

William M. Combs has been appointed vice president of the Gulf division of Walworth Co. Combs joined Walworth in 1926 as a field representative in engineering sales and subsequently served as manager of the Oklahoma division, Gulf division, and as Central division manager.

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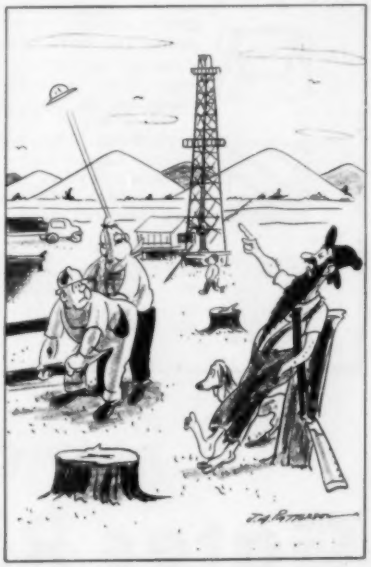

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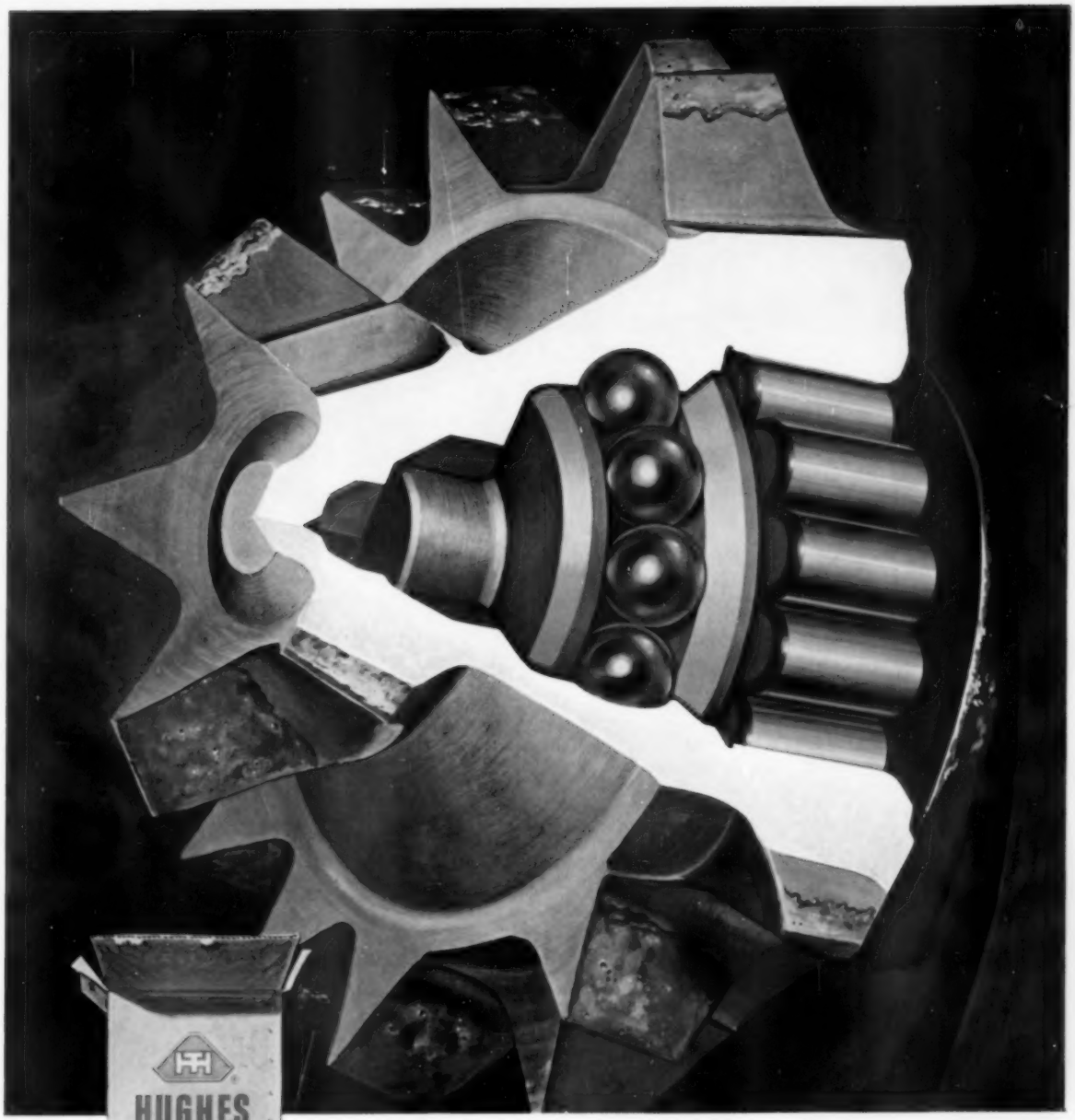

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